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TWENTIETH
ANNUAL REPORT

OF THE

MARYLAND
Agricultural Experiment Station,

COLLEGE PARK

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The Station is located on the B. & O. R. R. and City & Suburban Electric Car Line, eight miles north of Washington, D. C.
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Visitors will be welcome at all times, and will be given every opportunity to inspect the work of the Station in all of its departments.

The Bulletins and Reports of the Station will be mailed regularly, free of charge to all residents of the State who request it.

ADDRESS:

AGRICULTURAL EXPERIMENT STATION,
College Park, Maryland.

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LETTER OF TRANSMITTAL.

To His Excellency, Edwin Warfield,

Governor, and President of the Board of Trustees,

Annapolis, Md.

Sir:—In accordance with the provisions of Section No. 3, of the Act of Congress, approved March 2, 1887, "To Establish Agricultural Experiment Stations," etc., I have the honor to transmit the Twentieth Annual Report of the Maryland Experiment Station for the fiscal year ending June 30, 1907.

Very respectfully yours,

H. J. PATTERSON,

July, 1907. Director of the Experiment Station.

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THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

Volume 20. 1906-1907.

Report on the Work and Expenditures of The Maryland Agricultural Experiment Station.

FOR THE YEAR ENDING JUNE, 1907.

BY H. J. PATTERSON, Director.

To the Honorable Board of Trustees of the
Maryland Agricultural Experiment Station.

GENTLEMEN:—I again have the honor and privilege of presenting my annual report concerning the work, condition and needs of the institution under your charge.

The past year has marked a broadening of the scope of the work of the Station, and a general increase in its activities, which it is hoped will have an important bearing upon the agriculture of our State. The continued approval of the Station's efforts by the agricultural public is a reasonable assurance that our work is regarded as helpful.

The condition of the Station and its equipment is in the main gratifying and satisfactory to the Station workers; yet it is to be said that this institution is relatively in its infancy, and still in the process of development, and therefore real needs exist, which must be supplied if there is to be progress in efficiency and completeness of equipment and organization.

STATION STAFF.

The policy adopted by your board during the past year with reference to the graduation of the salaries of Station officers and assistants will certainly be a great help in the procuring and holding of desirable investigators, and the placing of the work on a higher and more staple basis. This policy will also do much toward maintaining the interest of farmers in our work, and in inspiring their confidence.

CHANGES IN STATION STAFF.

During the past year the following changes in Station staff have occurred:

Mr. William N. Hutt, who had served as horticulturist for two years, resigned November 1, 1906, to accept a similar position in North Carolina. This vacancy was filled by the appointment of C. P. Close, M. S., who entered upon his duties January 1, 1907. Mr. Close graduated at the Michigan Agricultural College in 1895. After graduation he spent some time in practical horticultural work in Michigan and California, and was assistant horticulturist at the Geneva (N. Y.) Station and horticulturist of the Utah and Delaware Stations.

Mr. P. M. Novik, of Cornell University, was appointed to the new assistantship in horticulture, and entered upon his duties in August, 1906.

The position of Dairy Husbandman, which had been vacant for some months, was filled September 1, 1906, by the appointment of Mr. C. W. Melick, a graduate of the University of Nebraska.

The position of Assistant Poultryman was filled December 1, 1906, by the appointment of Mr. C. L. Opperman, of Cornell University, who had also been connected with the poultry departments of the Michigan and Iowa Experiment Stations.

January 1, 1907, Mr. W. T. L. Taliaferro discontinued his work with the Experiment Station, so as to devote all his time to the College work. This vacancy was provided for by the appointment of V. M. Shoesmith, B. S., a graduate of the Michigan Agricultural College in 1901, and who had been Associate Agronomist at the Kansas Experiment Station since graduation.

Mr. E. O. Garner, who had filled the position of Superintendent of the Farm and Labor efficiently and very satisfactorily for eight years, resigned January 1, 1907. Mr. Garner's resignation was prompted by his desire to return to his family and farm in Carroll County, and his feeling that the duties of the position here were too arduous for a man of his years. This resignation was accepted by the board with much regret, and the position filled by the appointment of Mr. E. H. Brinkley, who had occupied this same position previous to Mr. Garner's appointment.

Mr. Raymond Outwater, Assistant Chemist, died February 9, 1907, and this vacancy was filled by the appointment of Mr. L. W. Fetzer, Ph. D., of New York, and a graduate of Munich, Germany.

Mr. M. N. Straughn, who had been with the Station for several years, resigned March 1, to accept a position with the United States Department of Agriculture, in charge of their sweet corn investigation. This vacancy was filled by the appointment of Mr. J. J. T. Graham, a graduate of this College, class of 1906, who will enter upon his duties July 1, 1907.

Mr. O. C. Gibbs, clerk, resigned March 1, to accept a clerkship in the United States Navy Department. This vacancy was filled by the appointment of Mr. Allan Park Davidson, of Carroll County.

The plan adopted one year ago for the division of time of College and Station men has proved satisfactory, and should be continued.

PUBLICATIONS.

The following is a list of the publications issued during the year:

Bulletin No. 110—September, 1906—Investigations on the Liming of Soils, by H. J. Patterson, pp. 1 to 56.

Bulletin No. 111—October, 1906—Oyster Shell Scale, by T. B. Symons, pp. 57 to 70.

Bulletin No. 112—November, 1906—Treating San Jose Scale, by T. B. Symons and A. B. Gahan, pp. 71 to 88.

Bulletin No. 113—December, 1906—Tomato Investigations, by T. H. White and W. R. Ballard, pp. 89 to 112.

Bulletin No. 114—January, 1906—Fertilizer Experiments with Different Sources of Phosphoric Acid, by H. J. Patterson, pp. 113 to 144.

Bulletin No. 115—February, 1907—The Control of Insect Pests and Diseases of Maryland Crops, by J. B. S. Norton and T. B. Symons, pp. 145 to 208.

Bulletin No. 116—March, 1907—Marketing Fruit and Truck Crops, by William N. Hutt, pp. 209 to 257.

Bulletin No. 117—April, 1907—Molasses Stock Feeds, by H. J. Patterson and R. Outwater, pp. 259 to 290.

Bulletin No. 118—June, 1907—Alfalfa Growing in Maryland, by C. W. Nash, pp. 291 to 314.

Bulletins Nos. 110 to 114 have been mailed to the names on the General mailing list; Nos. 115 and 116 to the names on the Horticultural mailing list; Nos. 117 and 118 to the Dairy mailing list.

MAILING LIST.

The growth of the mailing list, though not as rapid as at some times in the past, has continued steadily during the year. The number of names on the list now is as follows:

1.	General List of Maryland Farmers	22,000.
2.	Horticultural List	5,000.
3.	Tobacco Growers' List	3,000.
4.	Creamery Patrons' List	1,000.
5.	Milk Shippers' List	1,000.
6.	Newspapers in Maryland	420.
7.	Agricultural Papers	220.
8.	Libraries	100.
9.	Farmers' Clubs in Maryland	35.

10.	Maryland Granges	60.
11.	Fertilizer Manufacturers	125.
12.	Farmers of Other States	2,000.
13.	Experiment Station Officers and Workers	1,200.
14.	Foreign List	180.

All publications are mailed to the Newspaper, Agricultural papers, Libraries, Experiment Station workers and Foreign lists.

BUILDINGS.

The total amount which this Station has invested in buildings is only about $28,000, which includes four houses for laborers. This is much less than is frequently appropriated in many States for a building for a single department, and less than one-fifth what many States are spending on their main building for use in agricultural investigation or instruction. In general, it would seem to me that the policy of giving money for work, rather than building, when only a limited amount is available, is much wiser than to give money for building without anything to maintain them with. I am convinced that in many cases too much stress has been placed on the value of the building, and not enough upon the character of work being performed. Many of our young men think that elaborate equipments and buildings are absolutely essential for investigations, and are forgetful that some of the greatest scientists have conducted their work in attics and cellars, and some of the most lasting discoveries have been made with home-made improvised apparatus. While mindful of all of these conditions, yet I do appreciate that the public looks for something larger, more elaborate and substantial than is found in most of our structures, and that a good, well-appointed building seems to add dignity to the institution, and aids in commanding respect.

Taking all into consideration, I would recommend that your board take some steps in the near future to provide such buildings as will be required by the development of our work. If it is not possible or feasible to get a large amount at any one time, then to outline a schedule, which can be properly provided for, and to be carried out gradually through a series of years, and thus be able to meet the emergencies in a substantial way, as the work grows.

A scheme for a general agricultural building for both instruction and investigation might be possible, yet would require more outlay at once than the having of one department at a time.

The new barn and green-houses provided for last year are now in course of erection, and will probably be ready for occupancy by the middle of the summer, or early fall.

The hollow cement block-house has been completed, and is proving very satisfactory. It cost about 25 per cent. more than frame construction, but is much more substantial, and presents a nicer appearance.

INVESTIGATIONS.

The investigations which have been completed or advanced sufficiently to make a report of progress on are covered in the list of publications issued during the year.

The following is a list of the investigations being pursued by the different departments:

AGRONOMY.

The work of this deparment was under the direction of Mr. W. T. L. Taliaferro up until January 1, 1907, when he gave up his Experiment Station work, so as to devote his entire time to his College duties. On January 1 this department was placed in charge of Mr. V. M. Shoesmith. The work in progress at present is as follows:

1. CORN EXPERIMENTS.

(a) Breeding of Leaming and Munnikhuysen Corns, including a plan for the introduction of new blood into the breeding plots.

(b) Testing of the degree of inbreeding or close breeding, which may be safely practiced.

(c) Variety tests; 23 varieties of corn are being grown at present on the Station farm, and co-operative tests with five farmers in different parts of the State.

2. COW-PEAS.

(a) A study of the crop with reference to the improvement of the plant for Maryland conditions.

(b) A study of the methods of harvesting and threshing cowpea seed.

3. ALFALFA EXPERIMENTS.

(a) Breeding.
(b) Testing seed from different sources.
(c) Fertilizer tests.
(d) Methods of the preparation of seed-beds.
(e) Cutting experiments.
(f) Culture experiments.

4. CLOVERS—EXPERIMENTS WITH RED, MAMMOUTH, ALSIKE AND WHITE CLOVERS.

(a) Breeding experiments.
(b) Test of seed from different sources.

WHEAT EXPERIMENTS.

(a) Improvement by selection.
(b) Improvement by breeding.

Some preliminary work is being done looking toward the taking up of new lines of work, and plans are being devised for the enlarging of the facilities and equipment for this department, so as to enable the work to be produced and pushed forward with more rapidity.

BOTANICAL DEPARTMENT.

The usual investigations of cases of plant diseases arising from time to time have been made, and information with reference to the same have been given either by personal interviews or by letter. Many weeds and plants have been identified and named for farmers, and numerous samples of seeds tested as to purity and vitality.

Investigations are now in progress on the diseases of clover and alfalfa, and a detailed study is being made of the weeds of the State and methods of destroying the same.

CHEMICAL DIVISION.

The work in this department is mainly a continuation of the investigations outlined in the Eighteenth Annual Report, and caring for the general analytical work of the different departments, and the miscellaneous samples which come in for examination.

DAIRY DIVISION.

The principal work in this division during the year has been confined to a study of physical and chemical constituents which affect the food value of milk and determining just what effect each factor has on digestion.

Some studies have been made on the flavors of milk and the conditions which influence their development.

DEPARTMENT OF ENTOMOLOGY.

The past year, owing to extreme climatic conditions, was rather adverse to the conducting of several experiments that had been previously planned. An attempt will be made to either duplicate or carry out the original plans this year. The following may be stated as the lines of work in progress or planned:

1. An investigation of the life history, habits and most effective means of control of the Peach Scale (Eulecanium Nigro-faciatum).
2. An investigation and study of the green-house pests of Maryland.
3. A study of the life history and experiments with different

treatments for the control of the Scurfy Scale (Chionasphis Furfura).

4. Testing different treatments, and studying the life history of the codling moth (Carpocapsa Pomonella).

5. Testing different mixtures and devices as preventatives for the peach tree borer, in co-operation with the Bureau of Entomology, United States Department of Agriculture.

6. Experiments testing various spray solutions for the San Jose scale.

7. Experiments on fumigation of nursery trees with hydrocyanic acid gas; also testing various strengths of the gas on peach buds.

8. Experiments with different materials for the control of the Woolly Aphis in nurseries.

MOSQUITO WORK.

A mosquito survey of the State has been commenced by this department, but lack of funds has prevented its progress and completion. There is great need in the State for vigorous work in mitigating this dreaded pest.

Not only should efforts be exerted in the low and marshy areas, but also in all the small towns of the State where negligence as to breeding places of the pest abound.

It is pleasing to note here the results of the agitation from many sources on this subject in Baltimore City, in which vicinity most of the work conducted by this department, and published in Bulletin No. 109, of this Station, was done. There is now an ordinance in force requiring that breeding places of the mosquito be destroyed, and a penalty for those persons responsible for neglect. These requirements should be extended to all parts of the State, and this department should be vested with the powers for a rigid enforcement of same.

SPRAYING DEMONSTRATIONS

The conducting of spraying demonstrations in different parts of the State have been found to be producing the best results in arousing interest among farmers to the importance of such practice. While this phase of the work has been as yet confined to treating of orchard trees for the control of the San Jose scale, it is hoped to extend the work in the treatment of injurious insects attacking other horticultural and agricultural crops. Several of the above demonstrations have been conducted the past winter and spring, all of them being well attended by the farmers in the vicinity. The practical work of making and applying a given remedy seems to more forcibly appeal to those present than a verbal description of the operation.

SAN JOSE SCALE.

It is a source of satisfaction to report the decidedly improving condition as regards the infestation of this insect in the majority of orchards in the State. Among the progressive orchardists this insect is now looked upon as one that can be easily controlled by the application of the proper remedies. There are many small orchardists and even large vicinities in some parts of the State where negligence in the control of the insect is very apparent. This is especially true in the small towns of the State. The Osage Orange Hedge is now no doubt a most serious menace in the distribution of the insect. Active measures must be taken by the department in the future, requiring the treatment of such hedges all over the State.

PUBLIC SPRAYER.

The inauguration of a public spraying apparatus by the department this past spring to meet the demands of citizens of the small towns has been very successfully conducted, considering the circumstances under which it has operated. This is probably the first public sprayer ever conducted by a State Department. It was found that a public sprayer can be made self-supporting, when properly conducted, without making excessive charges for work done, and that the same is hailed with much satisfaction by the citizens of small towns, or those who have a small number of trees, requiring treatment.

ORCHARDS AND NURSERY INSPECTION.

The usual amount of inspection of orchards, nurseries, etc., has been conducted, and considerable new territory covered.

HORTICULTURAL DEPARTMENT.

Experimental work in progress January, 1907.

1. Asparagus fertilizers, begun spring 1904; 20 plots, each one-hundredth acre, located south of apple orchard.
2. Permanent sweet potato plots, begun 1902; sweet potatoes planted every year since; three plots, 32' by 67'. (1) Manure lot; (2) nothing; (3) commercial fertilizer, located north of asparagus bed.
3. Series C; 10 plots east of experimental orchard, begun spring 1904; fertilizer tests on vegetables; organic vs. inorganic and stable manure.
4. Experimental apple orchard. Cover crops, begun 1900.
5. Series A; fertilizer tests begun 1902. Com. Fert. vs. manure and green crops. Economic methods of application to vegetables.
6. Series B; fertilizer tests begun 1903 (same as No. 5).
7. Block 6; variety test gooseberries and currants.
8. Block 7; variety test raspberries and blackberries.
9. Strawberry mulching test, begun 1901 (Block 4, 1907).
10. Variety test strawberries, plot by Director's house.
11. Orchard back of President Silvester's house, planted 1897. Varieties of apples, dwarf and standard pears.

12. Vineyard, south of College. Variety test and training exp., begun 1903.
13. Variety plum orchard, south of College. Planted 1903.
14. Variety cherry orchard, south of College. Planted 1903.
15. Variety apples, crab apples and nuts, south of College. Planted 1903-1905.
16. Orchard for student work, planted 1902. Variety applies, with variety as fillers.
17. Apple orchard, southwest College; four varieties grafted on Paradise, Standard and French stock. Planted 1906.
18. Variety potato tests. Effect of time of harvesting and cold storage on seed.
19. Pear breeding, begun 1905.
20. Strawberry breeding, begun 1898; selection from seedlings.
21. Test of flowering plants, begun 1906.
22. Variety test of tomatoes.
23. Green-house experiments.
    - Rotation of crops, chrysanthemums, lettuce, cucumbers.
    - Solid bed vs. benches.
    - Application of phosphates in different forms as affecting soil continuously used.
    - Test of cover crop soils.
    - Fertilizer in solution for chrysanthemums.
    - Surface vs. sub-irrigation with carnations and lettuce.
    - Carnation breeding; selection from seedlings.
    - Effect of fertilizers on stiffness of stems of carnations, begun 1904.
    - Continuing the vigor of carnations by cuttings made from side shoots, main branches and piped cuttings.
    - Fertilizers on violets.
    - Soil and fertilizers for primulas.
    - Variety test of geraniums.
24. Crops for young orchards, E. P. Cohill's, Hancock, Md.
25. Variety peach orchard, E. P. Cohill's, Hancock, Md.
26. Variety peach orchard, W. F. Allen's, Salisbury, Md.

NEW WORK OF 1907.

1. Introduction of the hardiest of the Persian walnuts for Maryland. A survey of the present status of walnut growing in the State, with a view of publishing a bulletin on this subject next winter.

2. Spraying with different strengths of Bordeaux mixture on apples at the Experiment Station and at E. P. Cohill's.

3. Apple Breeding, to originate a variety earlier than any we now have, especially a red variety. Also to obtain a very late good quality red apple.

4. Pear breeding.

Planting a dwarf pear and dwarf apple orchard for the plant-breeding work.

6. Growing of forestry seedlings.

7. Growing mushrooms; a list of varieties and different kinds of spawn; also different times of spawning the same house.

8. Cultivation of artichokes.

9. Introduction and improvement of the paw-paw.

10. Introduction of timber trees from California.

11. New raspberry plantations; test distances apart of planting and pruning and training.

12. Treatment of soils with fertilizers and otherwise, as affecting late cabbage.

13. Effect of fertilizers on the structure of plants.

14. Copper sulphate on plants; can copper sulphate in very weak solution cause a plant to become immune to disease.

15. Determining the life of apple pollen.

16. Rooting apple cuttings.

17. Gooseberry and currant commercial fertilizers vs. hog manure.

18. Variation in plants by excess of food fertilizers in various forms.

19. Test of blight-proof muskmelons.

20. Tests of foreign vegetable seeds and potatoes.

POULTRY INVESTIGATIONS.

This is a new department of the Station, now only about six months old, but one that probably will appeal to more people than any other, for practically every farm and every village and suburban place has some interest in poultry. In the past five years the value of poultry products in Maryland has increased over a million dollars. With this rapid growth has come a demand for information relative to the poultry business in its various phases, such as equipment, incubation, breeding, feeding, etc.

There is much need for some definite, economic information on these points. It certainly is not a good commercial proposition to spend ten dollars for pen for housing, if 75 cents will do just as well. The average loss at present in hatching and raising chickens to a table size represents about 75 per cent. of the eggs set, and makes a chicken, when out of the shell, cost about 12 cents each. Certainly this should not be, and offers an important field for investigation.

During the month of January the Department secured 100 White Leghorn pullets. From this flock over 700 chicks have been hatched, which will be used for experimental work. Several experiments have been planned and outlined, and will be started as early as possible.

The lines of work to be taken up are as follows:

(a) A careful study of the different types of poultry houses, to determine as far as possible which one is best adapted to Maryland's climate. Careful records of the egg production, health of the fowls, amount of food consumed, hatchability of the eggs, etc., will be kept for each separate pen.

(b) Breeding of Barred Plymouth Rocks for egg production.

(c) A series of experiments will be started in the near future to determine, if possible, the reason for low percentage of chicks hatched in machines; also why we find large numbers of fully-developed chicks dead in the shell, etc.

(d) The feeding of different rations for egg production will be carefully studied.

VETERINARY DEPARTMENT.

The scope of the Veterinary Department of the Station was greatly broadened during the year through the allotment of more time and increased facilities for work.

Tuberculosis:—In continuing the work upon tuberculosis and tuberculosis immunization in cattle there have been a number of tuberculosis tests conducted, of which the same shows interesting results. In a lot of five registered cattle, four (80 per cent.) reacted; in a lot of 16 grades principally, eleven (68¾ per cent.) reacted; in a lot of 52 mixed breeds and grades, thirteen (25 per cent.) reacted.

These represented average herds, and it is believed that they show the probable extent of tuberculosis existing among dairy cattle of Maryland.

The condition is serious, as affecting the dairy industry, and as a result of the recent agitation and legislation upon matters of pure food and meat inspection tends to produce an undesirable reaction within the confines of the State. Animals which under old conditions would have found their way to the abattoirs after reaction to the tuberculosis test are now apt to be bartered about, and many eventually return to the dairies for further milk production. This matter has already been noted by the State Board of Health and the State Live Stock Sanitary Board, and they both are alive to the necessity for remedial measures. Our Station should be prepared to assist in this matter as a safeguard both to the public health and to the welfare of the dairy man. It is our function to foster the industry, rather than to depress it, and it appears that we have a double duty and a delicate duty in the matter of tuberculosis regulation.

Tuberculosis in hogs has enormously increased in proportion to the number of creameries established, and cream separators employed on the farms. This has been observed throughout the country, and Maryland is not an exception.

Bovo-vaccinations have been made at eight different farms in the State, upon sixty-seven calves ranging from two weeks to six months of age. No ill effects have been observed from its use in any case, and while our experiences have been for too short a time to draw proper conclusions, yet all preliminary work completed is highly encouraging. Two Bovo-vaccinated animals are being subjected to a test to prove the duration of immunity after two years has elapsed since treatment, and test will be concluded in a few weeks.

Leucoencephalitis in horses appeared in three sections of the State during the year. No advances were made in determining the cause of the disease, but this was really the first opportunity offered since the report on the disease was published, to confirm the work published in that report. The results of post-mortem examinations at each of the three sections visited fully confirms the work previously done, and, further the lesions there described are constant in all cases dying with this disease.

A careful and thorough trial of anti-streptococcic serum was made with negative results in every case.

Milk Studies:—Leucocytes and pus cells in milk, together with milk production studies in general, have been made during the year.

The Doane-Buckley method of enumeration of cells in milk was carefully worked over, and with very slight modifications gave the most consistent results in comparison with other recommended methods.

Quite a number of features developed in the course of this work, which made contradictory the accepted theories of milk production and composition. An interesting field is open for further work.

CO-OPERATION AND DEMONSTRATION EXPERIMENTS.

The following lines of work are being conducted in co-operation with the United States Department of Agriculture.

1. Alfalfa experiments.
2. Wheat breeding.
3. Sugar corn breeding.
4. Study of the effects of environment on the sugar contents of sweet corn.
5. Tobacco investigations.
6. Preventatives for the peach tree borer.
7. Study of the effects of different crop rotations on the maintenance of the fertility of the soil.

In addition to the work being done in co-operation with the United States Department of Agriculture considerable work is in progress in different parts of the State in co-operation with farmers. This work has been covered in the outlines given under the different departments.

FINANCIAL CONDITION.

As appears from the report of the Treasurer the finances of the Station are in good condition, and the year's work has been carried on within the funds available, and small balances remain. It has been the general policy of this institution to run on practically a cash basis, and contract no debts that cash was not on hand to meet at once. All bills are settled in full at close of each month, and where discounts are allowed for cash in five to ten days they were availed of.

With the improvements in the character of work of all of the departments; and the general expansion which has been taking place during the past year, the expenses have increased very materially. The increased cost of labor and all materials has also added considerable to the usual calls for money. While larger amounts of money could be efficiently and profitably used, it is felt that the constituency of the Station should be given convincing evidence that the increase with which we were favored by the last legislature is being used to good advantage before asking for any further endowment. Consequently, it is recommended that the legislature be asked to continue the appropriation received during the past two years for the next two, and this will be absolutely necessary to continue our poultry investigations, and provide for the printing of our bulletins in as large editions as are required to meet the demands.

HATCH FUND.

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES APPROPRIATION.

DR.

1907.

To receipts from the Treasurer of the United States, as per appropriations for the fiscal year ended June 30, 1907, as per Act of Congress March 2, 1887..............$15,000 00

CR.

1907.			
June 30,	By	Salaries	$7,774 95
	"	Labor	2,386 40
	"	Publications	976 24
	"	Postage and Stationery	326 09
	"	Freight and Express	194 83
	"	Heat and Light	475 71
	"	Chemical Supplies	21 95
	"	Seeds, Plants and Sundry Supplies	418 96
	"	Fertilizers	262 50
	"	Feeding Stuffs	349 55
	"	Library	289 49
	"	Tools, Implements and Machinery	516 04
	"	Furniture and Fixtures	107 95
	"	Live Stock	462 50
	"	Traveling Expenses	229 51
	"	Contingent Expenses	31 58
	"	Buildings and Repairs	175 75
		Total	$15,000 00

The above is a true copy from the books of this office.

(Signed) JOSEPH R. OWENS,

Treasurer Maryland Agricultural Experiment Station.

ADAMS FUND.

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES APPROPRIATION.

Dr.

1907.

June 30, To receipts from the Treasurer of the United States, as per appropriations for the fiscal year ended June 30, 1906, as per Act of Congress March 16, 1906..........$7,000 00

Cr.

1907.			
June 30,	By	Salaries	$3,871 96
	"	Labor	849 25
	"	Postage and Stationery	16 78
	"	Chemical Supplies	318 60
	"	Seeds, Plants and Sundry Supplies	73 86
	"	Feeding Stuffs	362 00
	"	Library	26 77
	"	Tools, Implements and Machinery	54 11
	"	Furniture and Fixtures	12 00
	"	Scientific Apparatus	966 93
	"	Traveling Expenses	97 74
	"	Buildings and Repairs	350 00
		Total	$7,000 00

The above is a true copy from the books of this office.

(Signed) JOSEPH R. OWENS,

Treasurer Maryland Agricultural Experiment Station.

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE STATE OF MARYLAND APPROPRIATION.

1906.	Dr.		
June 30,	To Cash Balance	$4,303	17
1907.			
June 30,	Receipts from the State of Maryland for the fiscal year ending September 30, 1906	$5,000	00
		$9,303	17
1907.	Cr.		
June 20,	By Repairs to Buildings	$1,038	59
	" Insurance	367	31
	" Publications	1,554	57
	" Exhibits	1,030	57
	" Feeding Experiments	1,942	65
	" Tobacco Experiments	78	36
	" Poultry Investigations	2,971	69
	" Demonstration Work	315	91
	" Balance	3	52
	Total	$9,303	17

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE STATION FARM.

1906.	Dr.		
July 1,	To Balance	$21	41
1907.			
June 30,	To Sales of stock and produce since July 1, 1906	6,344	22
		$6,365	63
1907.	Cr.		
June 30,	By Labor	$ 3,171	78
	" Freight and Express	$ 229	04
	" Seeds, Plants and Sundry Supplies	662	61
	" Feeding Stuffs	2,000	00
	" Live Stock	295	00
	" Contingent Expenses	6	00
	" Balance	1	20
		$5,182	63

The above is a true copy from the books of this office.

(Signed) JOSEPH R. OWENS,

Treasurer Maryland Agricultural Experiment Station.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 110. SEPTEMBER, 1906.

RESULTS OF EXPERIMENTS ON THE LIMING OF SOILS.

By H. J. Patterson.

PREFACE.

The experiments reported upon in this bulletin are a continuation of those given in Bulletin No. 66, issued six years ago. This will make the final report upon these experiments as the land used in these tests is no longer available for use by the Experiment Station.

In addition to the discussion of the results of the experiments there will be appended to this bulletin some general information on liming soils and the analyses of the lime and limestone made at this Station. Some of this matter was given in Bulletin No. 66; but as the supply of this bulletin was exhausted several years ago and the demand for the information still continues it has been considered advisable to repeat and supplement it at this time.

Experiment No. 1.

The Results of Applications of Lime on the Yields of a Common Crop Rotation.

This experiment was commenced in the spring of 1893 and results of the progress reported in Bulletins Nos. 56 and 66. The object of the experiment was to note the effect of lime on a rotation of crops, consisting of corn, wheat, and timothy and clover for two years.

There were two plots, containing one-fourth acre each, used in this experiment. Plot No. 1 received two applications of lime in the thirteen years during which the test ran. The first application, of twenty bushels of stone lime per acre, was made in the spring of 1893 previous to planting the land to corn, and the second application of twenty-five bushels of shell lime per acre was made in the spring of 1897. Plot No. 2 received no lime. The treatment of the two plots in all other respects was exactly the same.

The following commercial fertilizers and manure were applied to these plots; each plot receiving exactly the same quantity. At the last cultivation of the corn on July, 1897, crimson clover was seeded. This made a fair stand and growth. It was plowed under as a green manure on May 28th, 1898, and the land worked down and then harrowed from time to time during the summer preparatory to seeding the plots to wheat on September 29th, 1898. There were 400 lbs. of commercial fertilizer per acre applied at the time of seeding the wheat. The fertilizer was made up as follows:

Dissolved Phosphate rock,	1200	Pounds.
Bone tankage, (10%)	400	“
Nitrate of soda,	100	“
Muriate of potash,	300	“
Total	2000	“

This would average approximately as follows:

Phosphoric acid,	9½%
Nitrogen,	2 %
Potash,	7½%

The plots were plowed December 9th, 1901, for the corn crop of 1902, and on March 26th, the land was top-dressed with stable manure at the rate of ten tons per acre. This manure was worked into the land in May with the "Cutaway" harrow.

The corn was harvested and removed from the land October 8tn, and the land seeded to wheat October 27th, 1902. The delay in seeding was caused by wet weather and the low wheat yields may largely be attributed to this late seeding. The following fertilizer was drilled in at the time of seeding the wheat:

Dissolved phosphate rock,	1400	Pounds.
Dried fish,	300	“
Nitrate of soda,	100	“
Muriate of potash,	200	“
Total	2000	

This analyzed approximately as follows:

Phosphoric acid,	10 to 11%
Nitrogen,	2%
Potash,	5%

Corn was planted in rows three feet, nine inches apart and one stalk each fifteen inches in the row.

Wheat was seeded at the rate of six pecks per acre. Timothy was seeded in the fall at time of seeding the wheat at the rate of six (6) quarts per acre and clover in the spring at the rate of six (6) quarts per acre.

Results of Experiment No. 1.

The results of this experiment are set forth in detail in Table I. Page 4. It will be noted that crops were removed from the piece of land each year except in 1898; when a crop of crimson clover was grown and turned under as green manure. The crop of hay for 1904 was harvested and was a fairly good crop, but the weights were lost through an accident, consequently cannot be given; but it is quite certain that they would not materially change the results or the conclusions.

In estimating the relative gains produced by the lime, the following values were placed on the crops: Corn at 40 cents per bushel; Corn fodder 20 cents per Cwt.; Wheat at 90 cents per bushel; Straw at 20 cents per Cwt., and Hay at 50 cents per Cwt.

In the estimate the hay from the limed and unlimed plots were rated as being of equal value, but in fact the hay from the unlimed plot was of very much poorer quality than that from limed plot.

It will be noted in every case that the limed plot gave a better yield than the unlimed one and that the average net return was $4.50 per acre per year. While this may seem to be small at first, yet when applied to a 100 or a 150 acre farm it would mean from $450. to $600. more for each farm annually.

This certainly should impress all persons farming land that requires lime with the desirability, in fact, the necessity of its use. If only one-fourth of the cultivated land in Maryland would show a similar response to the use of lime it would make possible an annual increase in the net returns from the farms of over five millions dollars.

TABLE I.

Yield, Relative Gains and Profits per Acre of Limed and Unlimed Plots.

(Size of plots, one-fourth acre—Duration of Experiment 1893 to 1905).

CROP AND YEAR.	Plot 1. Limed.		Plot 2. Not Limed.		Gains as a Result of Liming.				
					Yields.		Value of Increase.		
	Grain, bu.	Hay, Fodder or Straw, lbs.	Grain, bu.	Hay, Fodder or Straw, lbs.	Grain bu.	Hay or Fodder lbs.	Grain.	Hay or Fodder.	Total.
Corn, 1893	21.4	2200	15.8	1792	5.6	408	......	......	......
“ 1897	43.6	2015	26.0	1475	17.6	540	......	......	......
“ 1902	57.0	5900	43.0	5080	14.0	820	......	......	......
Total, 3 Crops Corn	122.0	10115	84.8	8347	37 2	1768	$14.88	$3.54	$18.42
Wheat, 1894*	31.3	......	22 8	......	8.5	......	......	......	......
“ 1899	31.4	1014	22.5	768	8 9	246	......	......	......
“ 1903	7.3	1040	4.7	756	2.6	284	......	......	......
Tot'l 3 Crops Wheat	70.0	......	50.0	......	20.0	530	$18.00	$1.06	$19.06
Hay, 1895	......	2662	......	1391	......	1271	......	......	......
“ 1896	......	756		360	......	396	......	......	......
“ 1900	......	2000	......	960	......	1040	......	......	......
“ 1901	.....	2440	......	1780	......	660	......	......	......
“ 1905	......	2300	......	1820	......	480	......	......	......
Total, 5 Crops Hay†	......	10158	......	6311	......	3847	......	......	$19.23

Total profit on 11 crops	$56.71
Cost of lime, 2 applications, (45 bushels)	7.20
Net profit	49.51
Profit per crop per acre	4.50

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*Yield of straw not recorded.

†Yield of 1904 hay crop lost.

EXPERIMENT No. 2.

Testing the Lasting Effects of Different Quantities of Lime.

This experiment was commenced the spring of 1896. A report of progress of the experiment was made in Bulletins Nos. 46, 56, and 66. The land used in this test is a portion of College Park subdivision and is situated adjoining and east of the Pike and north of College Avenue. This piece of land is a stiff clay, and inclined to wet. Previous to its use for this experiment this land had not been cultivated for a number of years, and was very unproductive. The only growth on the land for years was a scanty growth of dewberry vines, sedge grass, and golden-rod. Very little vegetable matter had accumulated owing to the custom of annually burning off the tract.

The land was plowed in the spring, and the lime, which was slacked by means of water to a powdery condition was applied by means of a shovel and immediately harrowed into the soil. The rotation on these plots consisted of corn with wheat seeded in the fall in the corn stubble and timothy and clover seeded in the wheat and allowed to stand for hay one year.

The corn was planted in rows three feet, nine inches apart and one stalk each fifteen inches in the row. Wheat was seeded at the rate of six pecks per acre, with six (6) quarts of timothy per acre at the time of seeding the wheat and six (6) quarts of clover seed per acre in the spring. Aside from the difference in the quantities of lime applied the plots were treated in all other respects exactly alike. There was no fertilizer applied to the corn, but commercial fertilizer was drilled in with the wheat. Each plot received the same quantity of fertilizer.

For the 1897 wheat crop there was 600 lbs. of fertilizer used per acre
" " 1900 " " " " 400 " " " " "
" " 1903 " " " " 300 " " " " "
" " 1905 " " " " 400 " " " " "

The fertiizer used in 1900, 1903, and 1905 was made up as follows:

Dissolved phosphate rock,	1400	Pounds.
Tankage,	400	"
Nitrate of soda,	100	"
Muriate of potash,	100	"
Total	2000	

The formula used in 1897 was:

Dissolved phosphate rock,	1000	Pounds.
Tankage,	500	"
Nitrate of soda,	200	"
Muriate of potash,	300	"
Total	2000	

Results of Experiment No. 2.

The results in detail are set forth in Tables II to VII. In estimating the gain and relative profits the same values were placed upon the crops as those given in Experiment No. 1, Page 3. The results all show a marked advantage from the use of lime and give a net return that confirms the results set forth in Experiment No. 1, Page 3. In general the results covering the whole period of eleven years (see Table VII), favor the use of the larger quantities of lime, but the net returns from the larger quantities are not proportionately greater than those with the smaller quantities. In other words twenty bushels gave only about twenty-five per cent. more net profit than ten bushels instead of twice as much, as might be expected and sixty bushels only about fifty per cent. more instead of six times as much. From this it might be concluded that while the greatest profit would come from the use of fairly large quantities of lime, yet if only so much could be invested in lime that it would be better to put sixty bushels on six acres rather than on one acre and allow the five to go without. A study of Tables II to VII show that the effect of the application of ten bushels and twenty bushels of lime per acre showed approximately the same relative yearly increase throughout the whole period of eleven years, and in this respect acted just about the same as the fifty or sixty bushel applications, instead of showing a marked falling off or exhaustion as might have been expected.

TABLE II.

Showing the lasting effects of different quantities of Lime on the Yields of Corn.

(Yields per Acre.)

Plot No.	Quantity of Lime, bu.	1896.		1899.		1902.		1905.		Totals—4 Yrs.	
		Grain, bu.	Fodder,* lbs.	Grain, bu.	Fodder, lbs.	Grain, bu.	Fodder, lbs.	Grain, bu.	Fodder, lbs.	Grain, bu.	Fodder,* lbs.
1	10	23.9	......	35.2	1845	31.8	1724	34.5	2359	125.4	5928
2	20	25.6	......	28.5	2070	33.2	1969	31.1	2541	118.4	6580
3	No lime	17.4	......	30.5	1845	27.1	1860	22.2	2399	97.2	6104
4	30	25.8	......	34.8	2160	33.8	1815	30.4	2359	124.8	6334
5	40	27.1	......	36.5	2025	37.3	1815	35.1	2184	136.0	6024
6	No lime	15.3	......	23.4	1755	25.4	1679	21.7	2269	85 8	5703
7	50	28.8	......	39.8	2115	40.9	1997	34.7	2399	144.2	6511
8	60	29.8	......	42.4	2295	46.1	1815	37.5	2359	155.8	6469

*Yield of fodder in 1896 not recorded, as a strong wind storm blew some of the shock together and badly mixed them.

TABLE III.

Showing cost of Lime and value of gains from 4 Crops of Corn, per acre.

Plot No.	Quantity of Lime, bu.	Cost of Lime.	Value of Gains.*		
			Grain.	Fodder.	Total.
1	10	$ 1.80	$13.56	0.05	$13.61
2	20	3.60	10.76	1.35	12.11
3	No lime	....	....	....	....
4	30	5 40	13.32	0.86	14.18
5	40	7.20	17.80	0.24	18.04
6	No lime	....	....	....	....
7	50	9.00	21.08	1.22	22.30
8	60	10.80	25.72	1.13	26.85

*Corn valued at 40 cents per bushel and fodder at 20 cents per cwt.

TABLE IV.

Showing the lasting effects of different quantities of Lime on Yields of Wheat.

(Yields, per acre.)

Plot No.	Quantity of Lime, bu.	897.		1900.		1903.		1906.		Total, 4 Crops.	
		Grain, bu.	Straw,* lbs.	Grain, bu.	Straw, lbs.	Grain, bu.	Straw, lbs.	Grain, bu.	Straw, lbs.	Grain, lbs.	Straw, lbs.
1	10	26.0	......	15.2	1940	4.2	648	11.0	1143	56.4	3731
2	20	27.7	......	22.8	4380	4.7	576	11.3	990	66.5	5946
3	No lime	22.5	......	10.8	1180	3.0	360	6 2	612	42.5	2152
4	30	28.7	......	20.5	1880	4.7	576	9.0	675	62 9	3131
5	40	31.9	......	22.4	2560	7.3	864	8.4	936	70.0	4360
6	No lime	22.7	......	11.5	1580	3.4	603	7.4	594	45.0	2777
7	50	31.0	......	24.0	2450	9.0	900	5.6	1017	69 6	4367
8	60	32.5	......	20.1	2750	8.4	936	9.2	891	70.2	4577

*Weight of straw not recorded.

TABLE V.

Showing cost of Lime and value of gains from 4 Crops Wheat, per acre.

Plot No.	Quantity of Lime, bu.	Cost of Lime.	Value of Gains.*		
			Grain.	Straw.	Total.
1	10	$ 1.80	$11.43	$2.53	$13.96
2	20	3.60	19.52	4.96	24.48
3	No lime	....	....	....	....
4	30	5.40	17.28	1.33	18.61
5	40	7.20	23.67	3.79	27.46
6	No lime	....	....	....	....
7	50	9.00	23.31	3.81	27.12
8	60	10.80	23.85	4.23	28.08

*Grain valued at 90c. per bushel and straw at 20c. per cwt.

TABLE VI.

Showing the lasting effects of different quantities of Lime on Yields of Hay and value of gain per acre.

Plot No.	Quantity of Lime, bu.	Hay, 1898, lbs.	Hay, 1901, lbs.	Hay, 1904, lbs.	Total Hay, 3 crops.	Gains, lbs.	Value of Gain.
1	10	2502	2610	990	6102	2457	$12.28
2	20	2367	3060	1125	6552	2907	14.53
3	No lime.	972	2070	585	3627	....	....
4	30	2205	2880	1305	6390	2745	13.73
5	40	2322	2835	1485	6642	2997	14.98
6	No lime.	1053	1890	720	3663	....	....
7	50	2133	2610	1485	6228	2583	12.42
8	60	2286	2790	1665	6741	3096	15.48

TABLE VII.

Summary of relative profits obtained with different quantities of Lime all Crops (11 crops.)

Plot No.	Quantity of Lime, bu.	Cost of Lime.	Corn gain on 4 crops.	Wheat gain on 4 crops.	Hay gain on 3 crops.	Tota gain.	Relative profits with 11 crops.
1	10	$1.80	$13.61	$13.96	$12.28	$39.85	$38.05
2	20	3.60	12.11	24.48	14.53	51.12	47.52
3	No lime.	....	....	....	....	....	....
4	30	5.40	14.18	18.61	13.73	46.52	41.12
5	40	7.20	18.04	27.46	14.98	60.48	53.28
6	No lime.	....	....	....	....	....	....
7	50	9.00	22.30	27.12	12.42	61.84	52.84
8	60	10.80	26.85	28.08	15.48	70.41	59.61

EXPERIMENT No. 3.

Testing the Value of Green Manure in Connection with Lime.

The land used for this experiment was of the same general character and contiguous to the plots used in testing the different quantities of lime. It was divided into two plots of equal size. They were plowed and prepared for seeding May 12th, 1896, when stone lime was applied to plot No. 2 at the rate of forty bushels per acre. On May 13th, both plots were seeded to cow peas at the rate of five (5) pecks per acre without fertilizer. The difference in the growth of the peas on the two plots was quite apparent; both the color and density of the growth being in favor of the plot securing the lime. The peas on both the plots was plowed down August 24th. On October 2nd, they were

In this connection it is of interest to note the results covering the first four years of the experiment as given on Page 126 of Bulletin No. 66, which was as follows:

TABLE VIII.

Value of Gains Produced Per Acre With Different Quantities of Lime.

(In Dollars and Cents.)

Plot No	Quantity of Lime, bu.	Value of Lime, $	Value of Gain of Corn at 30 cts. bu., 1896.	Value of Gain of Wheat at 90 cts. bu., 1897.	Value of Gain of Hay at 50 cts. cwt., 1898.	Value of Gain of Corn, 1899.		Total Value of Gains.	Relative Profits From Gains.
						Gain at 40 cts. bu.	Fodder at 20 cts. cwt.		
1	10	1.80	2.28	3.06	7.45	3.28	0.09	16.16	14.36
2	20	3.60	2.79	4.59	6.78	4.60	0.54	19.30	15.70
3	No lime	....	....	....	....	....	....	....	....
4	30	5.40	2.85	5.49	5.97	3.12	0.72	17.97	12.57
5	40	7.20	3.24	8.37	6.55	3.80	0.45	22.41	15.21
6	No lime	....	....	....	....	....	....	....	....
7	50	9.00	3.75	7.56	5.60	5.12	0.63	22.66	13.66
8	60	10.80	4.05	8.91	6.37	6.16	0.99	26.48	15.68

The above table presents the results so clearly that it is almost useless to say anything further than to call attention to the fact that small applications of lime have proven to be as efficient at the end of four years as the larger application, and that the relative profits, up to date, are in favor of applying twenty bushes per acre.

From this we may conclude that small and frequent applications are probably preferable to large applications.

seeded to wheat and from that time on the plots were treated alike and the same rotation followed as with the plots receiving the different quantities of lime.

In Table IX is given the yields of those plots in ten years, together with the average of the "No Lime" plots for comparison and in Table X the relative profits resulting from their use.

The same prices were placed upon the respective crops in calculating the value of the grains as were used in Table I.

The results obtained in this experiment are decidedly in favor of using lime in combination with the green manure, (peas). The result no doubt would have been more marked in favor of the combination if more green manure could have been introduced at different times during the rotation.

TABLE IX.

Yields, per acre, resulting from the use of Cow Peas and Lime as Soil Improvers and Renovaters.

CROP AND YEAR.	No Lime.		Cow Peas, No Lime.		Cow Peas and Lime.	
	Grain, bu.	Hay, Fodder or Straw, lbs.	Grain, bu.	Hay, Fodder or Straw, lbs.	Grain, bu.	Hay, Fodder or Straw, lbs.
Wheat, 1897........	22.6	....	32.4	....	34.0	....
" 1900........	11.2	1380	14.2	1550	22.5	4320
" 1903........	3.2	482	4.2	693	6.0	585
" 1906........	6.8	603	6.9	846	7.1	1602
Total, 4 crops Wheat	43.8	2465	57.7	3089	69.6	6507
Hay, 1898...........	....	1012	....	1062	....	1638
" 1901...........	....	1980	....	1980	....	2610
" 1904...........	....	652	....	765	....	865
Total, 3 crops Hay..	....	3644	....	3807	....	5113
Corn, 1899......	27.0	1800	22.8	1215	27.0	1845
" 1902..........	26.2	1770	26.4	1951	31.4	1679
" 1905..........	21.9	2334	22.8	2541	32.0	2399
Total, 3 crops Corn..	75.1	5904	72.0	5707	90.4	5923

TABLE X.

Relative profits from the use of Cow Peas alone and Cow Peas and Lime in combination as Soil Improver.

	Corn.		Wheat.		Hay.	Totals and Relative Profits.
	Grain.	Fodder.	Grain.	Straw.		
Increased yield caused by cow peas	(—3.1 bu)	(—197 lbs.)	13.9 bu.	624 bu.	163 lbs.	
Value of increase	(— $1.24)	(—$0.20)	$12.51	$1.25	$0.81	$13.13
Cost of growing crop peas						5.75
Net profit in 10 years from use of peas						$ 7.38
Average profit per year or crop						0.74
Increased yield caused by peas and lime	15.3 bu.	19 lbs.	25.8 bu.	4042 lbs.	2069 lbs.	
Value of increase	$6.12	$0.04	$23.22	$8.08	$10.35	$47.81
Cost of peas and 40 bushels lime						12.95
Net profit in 10 years from use of peas and lime						34.86
Average profit per year or crop						3.48

EXPERIMENT NO. 4.

Testing the Value of Stable Manure in Combination with Lime.

In 1902 there was inaugurated an experiment to test the value of the use of stable manure in comparison with lime, also to determine the effects of using lime in combination with manure.

The land used for this experiment was contiguous to that used for Experiments Nos. 2 and 3, pages 5 and 9, and was of the same general character. The plots were cropped and treated the same as in the two preceding experiments.

The plots were plowed in December, 1901, and the manure applied April 30th, 1902, and worked into the land with a cutaway harrow and then the lime was applied on May 3rd as a top-dressing and incorporated with the soil with a harrow previous to planting to corn. The plots received only one application of manure and lime.

The results in detail are given in Tables XI and XII, and show very conclusively in favor of the use of both lime and manure, and decidedly in favor of using them in combination. The net profits per year from the use of twelve tons of manure and twenty bushels of lime per acre are greater than has been obtained in any of the other lime tests and are in a measure an explanation for the better crops which are obtained in those sections of the State that have used lime and manure extensively for generations.

TABLE XI.

Yields per acre resulting from applications of Lime and Stable Manure.

(Size of plots 30x60, or 4800 sq. ft.

Crop and Year.	No Lime.		20 bushels Lime.		12 tons Yard Manure.		12 tons Yard Manure and 20 bu. Lime.	
	Grain, bu.	Hay, Fodder or Straw, lbs.	Grain, bu.	Hay, Fodder or Straw, lbs.	Grain, bu.	Hay, Fodder or Straw, lbs.	Grain, bu.	Hay, Fodder or Straw, lbs.
Corn, 1902	26.2	1770	33.2	1969	57.1	3405	65.3	3267
" 1905	21.9	2334	31.1	2541	49.9	3220	66.3	2995
Total 2 crops corn	48.1	4104	64.3	4510	107.0	6625	131.6	6262
Wheat, 1903	3.2	482	4.7	576	5.8	234	9.0	982
" 1906	6.8	603	11.3	990	9.2	1071	10.5	1017
Total 2 crops wheat	10.0	1085	16.0	1566	15.0	1305	19.5	1999
Hay, 1904	......	652	......	1125	......	1980	......	2610

TABLE XII.

Showing increase, value of increase and relative profits from the use of Lime and Stable Manure.

	Corn.		Wheat.		Hay.	Totals and Relative Profits.
	Grain.	Fodder.	Grain.	Straw.		
Increased yield caused by 20 bushels lime	16.2 bu.	406 lbs.	6.0 bu.	481 lbs.	473 lbs.	
Value of increase	$8.48	$0.81	$5.40	$0.96	$2.36	$18.01
Cost of 20 bushels lime						3.60
Net profits from the use of 20 bushels lime						$14.41
Net profits per year or crop						2.88
Increased yield caused by 12 tons manure	58.9 bu.	2521 lbs	5.0 bu.	220 lbs.	1328 lbs.	
Value of increase.	$23.56	$5.04	$4.50	$0.44	$6.64	$40.18
Cost of 12 tons manure						12.00
Net profits from use of 12 tons manure						$28.18
Net profits per year or crop						$5.64
Increased yield caused by lime and manure	83.5 bu.	2158 lbs.	9.5 bu.	914 lbs.	1958 lbs.	
Value of increase	$33.40	$4.32	$8.55	$1.83	$9.79	$57.89
Cost of 20 hushels lime and 12 tons manure						15.60
Net profits from applications						$42.39
Net profits per year or crop						$8.48

EXPERIMENT NO. 5.

Comparing the Value of Different Sources of Lime and Ways of Applying the Same, Together with the Physical Effect of Some Other Materials.

With a view of studying the effects of different kinds of lime, and different modes of applying the same lime, also of endeavoring to test if the land was responding to lime as a plant food or only needing chemical and physical changes, the following series of experiments were outlined and entered upon in the spring of 1895. The land used in this test is a nice sandy clay loam, well drained, and would be considered of a nice character for general farming and truck crops. It is probably a little light for grain and grass, but a good tobacco and potato soil.

This piece of land was planted in cherry trees in 1889 and kept cultivated, but not cropped in the meantime. Many of the cherry trees had died out, and the remaining ones had made but little growth, so they were pulled out. For this test the land would permit of plots only ten feet wide and sixty-seven feet long with a two foot space between each plot. This gave the plots practically one sixty-fifth of an acre each. The plots were plowed May 24th, 1895, and lime was applied on May 25th. This is the only application of lime which was made.

The following table gives the application on which was made to each plot. The quantities applied in the case of lime were such as to give each plot the same quantity of Calcium Oxide, which was determined by analysis. Plots are numbered from tobacco barn toward the south.

Lime Experiments.

(Size of plots, 10x67 feet, with 2 feet space.)

Plot No.	Description of Application.	Quantity per acre, lbs
1	Stone Lime (Calcium Oxide-CaO). Fresh slaked and applied as a top dressing, not harrowed into the soil........	1400
2	Stone Lime (Calcium Oxide-CaO). Freshly slaked and harrowed into the soil immediately........................	1400
3	Oyster Shell Lime (Calcium Oxide) CaO). Freshly slaked and thoroughly worked into soil immediately............	1400
4	Oyster Shell Lime (Calcium Oxide-CaO). Worked into the soil before slaking....................................	1400
5	Magnesium Oxide (MgO), worked into the soil with harrow.	1400
6	Barium Oxide (BaO), worked into the soil with harrow....	1400
7	Nothing....	
8	Shell marl (Calcium Carbonate ($CaCO_3$), worked into the soil with harrow..	13000
9	Finely ground oyster shells (Calcium Carbonate, ($CaCO_3$)..	2600
10	Land Plaster, Gypsum (Calcium Sulphate,) ($CaSO_4$).......	4125
11	Gas Lime	2925
12	South Carolina Rock, finely ground (Calcium Phosphate) $Ca_3 (P O_4)_2$..	2925
13	Soft Coal Ashes..	13000
14	Complete Com. Fertilizer. { Double Superphosphate..200 Tankage.................100 Sulphate of potash....... 80 }	380

The rotation on the plots consisted of corn, wheat, and timothy and clover. There was a crop of crimson clover seeded in the corn in 1895, at the last working, and this was plowed under in the spring of 1896 for that year's corn crop. The corn crops of 1899 and 1903 and all of the wheat crops received an application of commercial fertilizer. The fertilizer, cultivation, etc., of all the plots was uniform throughout the experiment.

RESULTS OF EXPERIMENT NO. 5.

The yields obtained as a result of the various applications are classified according to the crop and given in detail in Tables XIII to XV, and a summary of them in Table XVI. From these results the following conclusions may be drawn:

AS TO METHOD OF APPLYING LIME.

1. The difference is not great, but slightly in favor of having the lime incorporated with the soil before slacking. This confirms the theory that the greatest chemical and physical effect should be procured by this system.

2. That the lime should be incorporated with the soil immediately upon application rather than put on as a top-dressing.

COMPARISON OF STONE AND OYSTER SHELL LIME.

3. The yields show a slightly greater increase from the use of oyster shell lime than from stone lime, although the difference is not very marked. See results on stone lime plots one and two, and oyster shell lime plots three and four.

COMPARISON OF PURE LIME (Ca O) WITH MAGNESIUM LIME (Mg O.)

4. The results show that magnesium oxide (lime) produced decidedly better yields of grain than the pure limes, though not quite as much forage. While it would not often be economical or practical to use pure magnesium lime, yet these results prove that magnesium is not poisonous to crops as is commonly believed. (Compare the yields of plots 1, 2, 3 and 4 with plot 5).

COMPARISON OF LIME (Ca O) MAGNESIUM OXIDE (Mg O) AND BARIUM OXIDE (Ba O).

5. Barium oxide was used in this experiment to determine what physical effect it might have, as it in no wise acts as direct plant food, or could be considered as such. A study of the results of plot No. 6,

and comparing them with those of the preceding plots it will be noted that the Barium oxide did not seem to have the lasting effect that the lime and Magnesium had, but that it produced a decided increase in the yields in the early years and not much in the later years. It seemed to have more effect in increasing the forage part of the crop than the grain. These results would seem to give a strong indication that the effect of the lime was more due to its chemical and physical action than to being a direct plant food.

COMPARISON OF CAUSTIC LIME ($Ca O$) WITH CARBONATE OF LIME ($Ca CO_3$).

6. On comparing the yields of plots 8 and 9 with plots 1, 2, 3 and 4, it will be noted that the carbonate of lime gave decidedly better results than the caustic lime. The only reason that can be offered for this result is that the soil being acid, liberated carbonic acid which was absorbed by the soil water and gave this water a greater dissolving action on other plant foods than it had previously with the other acids. Again, the chemical and physical action produced in the presence of carbonic acid may have been very different from that produced by the caustic lime. These results are particularly interesting as they have a decided bearing on the conditions found throughout the tide-water section of the State and the application of these results would make the application of lime available in lots of sections, which are not using any now and which would benefit greatly by its use.

RESULTS OF USE OF MARYLAND MARL.

7. It is particularly desirable to call special attention to the increased yield produced by the shell marl applied to plot No. 8. The marl used in this experiment was procured at Seat Pleasant in Prince George County, and was of about the composition represented by sample No. 587, Table XXV, page 53. It will be noted that the application of shell marl produced more grain and forage than either stone lime or oyster shell lime; in fact the marl plot produced more pounds of crop than any lot in the series. Shell marl is very abundant in many parts of Southern Maryland and the Eastern Shore and it should be used locally more largely than it is. All farmers who have access to deposits of shell marl should use it extensively and depend on it as their source of lime rather than purchasing caustic lime.

COMPARISON OF LAND PLASTER ($Ca SO_4$) WITH CAUSTIC LIME (CaO).

8. A comparison of the yields of plot 10 with those of plots 1, 2, 3 and 4 shows decidedly in favor of the use of caustic lime. The cost of application of the caustic lime was only about one-fourth as much as of the gypsum. These results show nothing to recommend the use of plaster.

COMPARISON OF GYPSUM ($CaSO_4$) AND FINELY GROUND OYSTER SHELLS ($CaCO_3$).

9. The yields obtained on plots 9 and 10 show very decidedly in favor of the use of finely ground oyster shells over gypsum. Their cost per ton is about the same and much less of the shells was used.

COMPARISON OF GAS LIME AND OYSTER SHELL LIME.

10. The comparison of the yields of plots 3 and 4 with those of plot 11, which received gas lime of oyster shell origin, shows quite conclusively in favor of the caustic lime rather than the gas lime. Gas lime is frequently purchased with the idea that it is very cheap, but when it is considered that gas lime is slacked lime which has absorbed a great deal of water and other impurities the relative cost is more than is at first apparent.

THE USE OF PHOSPHATE OF LIME.

11. The phosphate of lime in the form of finely ground raw phosphate rock produced a decided effect. The yield obtained with it was much better than with gypsum, but not so good as with either carbonate or caustic lime.

SOFT COAL ASHES.

12. The soft coal ashes produced little, if any, effect; certainly no increase of yield.

TABLE XIII.

Showing the effect of different sources of Lime on the yields of Corn per acre.

Plot Number.	Application.	Corn, 1895.		Corn, 1896.		Corn, 1899.		Corn, 1903.		Total 4 crops.	
		Grain, bu.	Fodder, lbs.	Grain, bu.	Fodder, lbs.	Grain, bu.	Fodder, lbs.	Grain, bu.	Fodder, lbs.	Grain, bu.	Fodder, lbs.
1	Stone Lime (CaO), slaked and applied as top dressing..........	42.7	2308	29.5	1950	17.5	4875	38.1	2308	127.8	11441
2	Stone Lime (CaO), slaked and harrowed into soil..............	43.1	2113	34.4	1900	10.7	4550	39.5	2665	127.7	11228
3	Oyster Shell Lime (CaO), slaked and harrowed into soil........	40.4	2145	38.5	2275	13.9	3900	37.1	3120	129.9	11440
4	Oyster Shell Lime (CaO), harrowed into soil before slaking....	41.9	2080	36.3	2145	11.5	5200	37.6	3088	127.3	12513
5	Magnesium Lime (MgO)	38.8	2210	34.4	2047	23.5	3250	43.6	2990	140.3	10497
6	Barium Oxide (BaO)...	36.8	2080	35.3	1852	12.7	4875	21.8	1885	106.6	10692
7	Nothing................	35.6	1950	27.8	1885	7.6	3900	26.5	2665	97.5	10400
8	Shell Marl, carbonate of lime ($CaCO_3$).........	42.0	2011	42.7	2112	19.4	4550	40.9	3185	145.0	11858
9	Finely Ground Oyster Shells, carbonate of lime ($CaCO_3$).........	48.8	2044	47.6	2535	22.3	5135	29.7	3120	148.4	12834
10	Land Plaster or Gyysum, sulphate of lime ($CaSO_4$)..............	40.9	2470	26.5	2145	15.1	3575	22.3	2210	104.8	10400
11	Gas Lime....	40.5	2178	27.8	1852	16.7	4550	18.2	1885	103.2	10465
12	Raw Phosphate Rock, phosphate of lime $Ca_3(PO_4)_2$................	38.5	2113	34.5	2242	9.0	4225	29.3	2340	111.3	10920
13	Soft Coal Ashes........	35.3	1950	24.1	1722	10.7	3775	28.8	2535	98.9	9982
14	Complete Commercial Fertilizer	34.1	2011	20.4	1527	21.9	3900	22.8	2437	99.2	9875

TABLE XIV.

Showing the effects of different sources of Lime on the yields of Wheat per acre.

Plot No.	Application.	Quantity, lbs.	Wheat, 1897.		Wheat, 1900.		Wheat, 1904.		Total, 3 Crops.	
			Grain, bu.	Straw, lbs.	Grain, bu.	Straw, lbs.	Grain, bu.	Straw, lbs.	Grain, bu.	Straw, lbs.
1	Stone Lime (CaO), slaked and applied as top dressing.......	1400	15.7	1202	13.0	1495	2.2	812	30.9	3509
2	Stone Lime (CaO), slaked and harrowed into soil............	1400	16.8	1397	13.0	1105	3.8	1105	33.6	3607
3	Oyster Shell Lime (CaO), slaked and harrowed into soil........	1400	14.6	1300	14.0	725	3.3	942	31.9	2967
4	Oyster Shell Lime (CaO), harrowed into soil before slaking.	1400	17.3	1527	14.0	1040	4.3	975	35.6	3542
5	Magnesium Lime (MgO).......	1400	20.0	1786	17.3	1560	2.2	1072	39.5	4418
6	Barium Oxide (BaO)...........	1400	16.8	1527	11.9	910	3.8	812	30.3	3249
7	Nothing........................	.....	14.6	1462	14.0	455	3.3	780	31.9	2697
8	Shell Marl, Carbonate of Lime ($CaCO_3$)	13000	22.2	1917	16.3	1625	4.9	1202	43.4	4744
9	Finely Ground Oyster Shells, carbonate of lime-($CaCO_3$)..	2600	22.2	1690	16.3	1300	3.8	1105	42.3	4095
10	Land Plaster or Gypsum, sulphate of lime-($CaSO_4$)........	4125	15.1	1527	13.0	1170	2.2	780	30.3	3477
11	Gas House Lime..............	2925	17.3	1690	16.3	975	1.6	1072	35.2	3737
12	Raw Phosphate Rock, phosphate of lime-$Ca_3(PO_4)_2$............	2925	17.9	1527	14.6	1742	2.7	845	35.2	4114
13	Soft Coal Ashes................	13000	13.4	1105	11.9	1235	1.6	520	26.9	2860
14	Complete Commercial Fertilizer	380	9.8	1105	9.8	1365	1.6	487	21.2	2957

TABLE XV.

Showing the effects of different sources of Lime on the yields of Hay per acre.

Plot No.	Application.	Quantity, lbs.	Hay—1898, lbs.	Hay—1901, lbs.	Hay—1902, lbs.	Hay—1905, lbs.	Total—4 Crops, lbs
1	Stone Lime (CaO), slaked and applied as top dressing............	1400	1560	1300	780	1950	5590
2	Stone Lime (CaO), slaked and harrowed into soil..................	1400	2535	1625	1300	1300	6760
3	Oyster Shell Lime (CaO), slaked and harrowed into soil...........	1400	2405	1950	2405	1300	8060
4	Oyster Shell Lime (CaO), harrowed into soil before slaking..........	1400	2665	1820	1105	1625	7215
5	Magnesium Oxide (MgO)..........	1400	2210	2600	325	1300	6435
6	Barium Oxide (BaO)..............	1400	1820	2340	715	1300	6175
7	Nothing........................	......	1365	1625	910	1300	5200
8	Shell Marl, carbonate of lime ($CaCO_3$)......................	13000	2925	2730	975	1950	8580
9	Finely Ground Oyster Shells, carbonate of lime ($CaCO_3$)..........	2600	2600	2275	1105	1950	7930
10	Land Plaster or Gypsum, sulfate of lime ($CaSO_4$)................	4125	1235	2275	780	1300	5590
11	Gas Lime	2925	1495	1690	845	1300	5330
12	Raw Phosphate Rock, phosphate of lime-$Ca_3(PO_4)_2$..................	2925	2145	1560	845	1625	6175
13	Soft Coal Ashes....................	13000	1495	1170	1495	1300	5460
14	Complete Commercial Fertilizer...	380	845	1105	520	975	3445

TABLE XVI.

Summary of the results of the effects of different sources of Lime on Corn, Wheat and Hay.

(Yields per Acre.)

Plot No.	Application.	4 Crops Corn.		3 Crops Wheat.		4 Crops Hay, lbs.	Total, 11 Crops.	
		Grain, bu.	Straw, lbs.	Grain, bu.	Straw, lbs.		Grain, bu.	Forage, lbs.
1	Stone Lime (CaO), slaked and applied as top dressing	127.8	11441	30.9	3509	5590	158.7	20540
2	Stone Lime (CaO), slaked and harrowed into soil....	127.7	11228	33.6	3607	6760	161.3	21595
3	Oyster Shell Lime (CaO), slaked and harrowed into soil	129.9	11440	31.9	2967	8060	161.8	22467
4	Oyster Shell Lime (CaO), harrowed into soil before slaking..................	127.3	12513	35.6	3542	7215	162.9	23270
5	Magnesium Lime (MgO)...	140.3	10497	39.5	4418	6435	179.8	21350
6	Barium Oxide (BaO).......	106.6	10692	30.3	3249	6175	136.9	20116
7	Nothing....................	97.5	10400	31.9	2697	5200	129.4	18297
8	Shell Marl, carbonate of lime ($CaCO_3$)............	145.0	11858	43.4	4744	8580	188.4	25182
9	Finely Ground Oyster Shells, carbonate of lime ($CaCO_3$)	148.4	12834	42.3	4095	7930	190.7	24859
10	Land Plaster or Gypsum, sulfate of lime $CaSO_4$.....	104.8	10400	30.3	3477	5590	135.1	19467
11	Gas Lime.............. .	103.2	10465	35.2	3737	5330	138.4	19532
12	Raw Phosphate Rock, phosphate of lime $Ca_3 (PO_4)_2$.	111.3	10920	35.2	4114	6175	146 5	21209
13	Soft Coal Ashes............	98.9	9982	26.9	2860	5460	125.8	18302
14	Complete Commercial Fertilizers..................	99.2	9875	21.2	2957	3445	120.4	16277

GENERAL RELATION OF LIME TO AGRICULTURE.

Lime was one of the earliest materials used for improving the productiveness of the soil, as is evidenced by the writings of Pliny and Cato. It was used in this way probably two or three hundred years B. C. That chalk and marl were quite extensively used at an early period in Southern Europe is shown by the notes of Varro, taken during the march of his army to the Rhine. The contributions of Ruffin in the "American Farmer" as early as 1818, show that the agricultural use of certain forms of lime took a prominent place in the agriculture of the United States early in its history.

Although lime was thus used early in the history of agriculture, and has been used to a greater or less degree in all parts of the agricultural world ever since, yet the nature of its action on the soil is but little understood and has been but slightly studied. Almost every one recognizes the fact that there is a great difference in the action of lime on soils of different characters. That there is a difference between the action of limes of different character and composition on the same soil is a point seldom noticed.

The term *"lime"* is generally understood to mean quick or caustic lime or Calcium Oxide (CaO). When any form of carbonate of lime; lime-stone, oyster shells, or shell marl, is burned, the carbonic acid is expelled and lime or quick lime is produced. In burning, the Calcium (lime) carbonate ($CaCO_3$) undergoes decomposition, carbonic acid being thrown off, and caustic quick-lime (Calcium Oxide, CaO) remaining in the kiln. The fuels generally used in burning lime are wood, charcoal, coal or coke, and the ashes from these will be found as impurities in the lime.

The kiln may consist of only a crude pile of logs, and wood so arranged as to admit the air and burn freely with the stone or shells piled inside and on top. They may vary in form and construction all the way from this crude type to those constructed of extensive and solid masonry or steel boiler plate lined on the inside with fire-brick, and so arranged that the lime may be perpetually drawn from the bottom while the stone and fuel are being fed at the top. While the types, sizes and details now in use vary considerably, yet the general form most approved is not very different from the description given by Cato. Some limes are burned in retorts, pots or crucibles, thus giving a pure lime, free from the contamination of ashes and unburned fuel.

Lime Burning—Lime-stone or any carbonate of lime begins to decompose at about 300 degrees C., and the temperature usually employed is indicated by a bright red heat. It ought not to exceed 1100 degrees C. The facility with which lime is burned depends upon the porosity and composition of the stone, the size of the lumps and the volume of air passed through the burning mass. Again the expulsion of carbonic acid is facilitated by the introduction of steam into the mass. This is accomplished by practical lime burners by watering lime-stone which has become dry by standing in the open air.

About one bushel of coal is required to make five or six bushels of lime, but dolomitic (Magnesium) lime-stones require less. If much argellaceous matter is present the lime-stone more readily fuses, and in such cases, great care should be exercised to keep the temperature below the melting point, otherwise the mass vitrifies and the lime resulting is said to be "dead burnt" or "over burnt." "Over burning" may also be due to the forming of a half-burnt lime by a strong and sudden ignition, or by means of high temperatures the silica and alumina, contained in the lime-stone, will become sintered over the surface of the lime, forming a slag or glass which prevents its coming in contact with the water and slacking.

From this it will be seen that the same conditions and heats can not be applied to all classes of lime-stones, and that it is necessary to take extra precautions when burning lime-stone of irregular character and composition. In fact it is well not to attempt to burn different veins of lime-stone in the same kiln at the same time. If it is desired to market different grades or veins of lime-stone, and at the same time place only one grade of lime on the market, these should be burned separately and combined after burning. Such a process, if carefully carried out, would prevent much of the trouble in lime slacking unevenly. It is well to have dampers in the kilns, to put the heat under better control.

In burning, lime-stone retains practically the same volume, but loses about 44 per cent. in weight; that is 100 pounds of stone yields about 56 pounds of lime.

Characteristics of Lime:—It is common to hear the terms "Agricultural lime" and "Building lime," used as if these were different articles. In reality, no such difference exists; they are simply trade terms; as the same lime is commonly used indiscriminately for the two different purposes. Sometimes, however, the name "Agricultural lime" is used to mean building lime that has been air or water slacked, and again it refers to the quality of the stone from which it was derived. If it were always thus used the term would have a distinct meaning. Unfortunately it is impossible to define or distinguish a building or agricultural lime even from a chemical standpoint, owing to the fact already stated that different soils respond differently to the same lime and *vice versa*. According to the nature of the lime-stone, it will turn out (a) a fat or rich lime; (b) a poor lime; or (c) an hydraulic lime. If lime-stone consists simply of pure Carbonate of Lime, then the lime obtained therefrom will slack readily, forming a creamy mixture with water, and is called fat or rich lime. On the other hand if the lime-stone contains Magnesia it slacks more slowly, forming a thin, poor mixture and is called a poor lime. With ten per cent. (10 per cent.) of Magnesia a lime is poor, and with twenty-five to thirty per cent. it is almost useless. If the lime-stone contains more than ten per cent. of silica the lime therefrom will have the quality of forming a paste, which will harden under water or in most places where it is not exposed to the drying influence of the air; such lime is known as hydraulic lime. It is very reasonable to suppose that the different limes act differently on the same soil or on soils of different characters, and much in the same manner as they do in forming mortars and cements.

KINDS OF LIME USED IN AGRICULTURE.

Stone Lime:—Good lime-stone contains from 50 to 55 per cent. lime (CaO), and 40 to 45 per cent. Carbonic Acid, with small amounts of magnesia, silica, iron and aluminia. Such lime, when burnt, would produce the best quality of caustic or quick-lime, and would contain from 90 to 98 per cent. of Calcium Oxide (CaO). Freshly burned lime, when removed from the kiln, will weigh about 90 or 95 pounds to the heaped bushel, and will slack about three bushels for one in volume.

Magnesia Stone Lime:—Magnesia lime-stone, or dolomites are quite varied in their composition, and may range in Carbonate of Lime from 20 to 80 per cent. and in Carbonate of Magnesium from 10 to 60 per cent. The average of such lime-stones used in agriculture, when burned, will produce a lime containing from 70 to 85 per cent. of Calcium Oxide and 5 to 20 per cent. of Magnesium Oxide. Magnesia lime weighs about 75 to 85 pounds to the heaped bushel, and will slack about two bushels for one, by volume.

Oyster Shell Lime:—Oyster shells contain from 90 to 95 per cent. of Calcium (lime) Carbonate, and will produce, when burned, a comparatively pure lime, which should contain from 85 to 95 per cent. of pure Calcium Oxide if it has not been excessively contaminated with impurities and the ashes from the fuel in burning. Freshly burned oyster shell lime weighs about 60 pounds per bushel, and will slake out a little better than two for one by volume.

Slaked Lime:—In the process of slaking lime it takes up water and forms Calcium or Lime Hydrate. It also absorbs some Carbonic Acid from the air and forms Carbonate of Lime. If different samples of lime or slaked lime are in equally good condition they may be thus compared:—

Kind of Lime.	Wt. per bu. before slaking.	Total wt. after slaking.	Number bu. after slaking.	Wt. per bu. after slaking.
Good Stone Lime	93 lbs.	135	3	45
Magnesia Stone Lime	80 "	110	2	55
Oyster Shell Lime	60 "	100	2½	40

Gas House Lime or Gas Lime:—Quick lime is used at the gas works for removing the impurities of the gas. After it has been saturated with the impurities, and no longer fit for use in gas making, it is sold for agricultural purposes under the name of gas-lime. This article varies considerably in composition, but consists essentially of the hydrate, carbonate, sulphate, sulphides and sulphites of lime. The sulphides and sulphites of lime are injurious to germinating seeds or young and tender plants, so that gas lime should be applied cautiously and when not too fresh. The action of the air on sulphides and sulphites changes them to sulphate of lime (gypsum or land-plaster); hence the exposure of gas-lime to the weather for some time improves its agricultural qualities. Average gas-lime contains about 22 per cent. water, 43 per cent. lime (CaO), 21 per cent. Sulphuric Acid (Oil of Vitriol), 8 per cent. Magnesia, and 6 per cent. insoluble matter. Of course this will vary considerably according to the character of the lime used, and the amount and nature of the impurities. The gas houses in Baltimore and Washington, D. C., use mostly oyster shell lime, and the gas lime from such lime would contain very much less Magnesia than indicated by the average figures. Gas-lime is usually sold at 65 pounds per bushel.

Gypsum or Land Plaster is a combination of lime with Sulphuric Acid (Oil of Vitriol) forming sulphate of lime. It occurs in nature in large deposits forming beds of rock. These are comparatively easily mined, and the rock is ground to a fine powder for commercial purposes. It varies in color from white or light yellow to gray. There are no natural deposits of gypsum in Maryland. Gypsum or sulphate of lime is formed artificially in the manufacture of phosphoric acid and phosphates, by treating the phosphates of lime with sulphuric acid, and a considerable amount of gypsum is necessarily used in agriculture in using dissolved bone and dissolved rock. Average gypsum contains about 32 per cent. Calcium Oxide (CaO).

Marl, is a name applied to earthy deposits containing more or less partially decomposed shells. These make the marl more or less friable or easily disintegrated by the weather. Marls are valuable as sources of lime, and, when they contain large amounts of lime, they are burned and thus furnish a source of quick-lime. Marls occur widely distributed in Maryland, and vary considerably in character and quality, as will be seen from the discussion and analyses in Table XXV.

Phosphates of Lime, are used extensively in agriculture, being furnished through the medium of bone, South Carolina, Florida and Tennessee phosphate rock, slag phosphates, and various guanos. These are really used for their phosphoric acid rather than for lime, and so are somewhat outside of the province of this bulletin.

MODES OF ACTION OF LIME.

In considering the question of the use of lime from a theoretical standpoint it would be very natural to conclude that lime is a necessary plant food. Lime is a substance that is just as essential to the plant as Nitrogen, Potash or Phosphoric Acid, and some of it must be present in the soil or no crop can grow. Nevertheless the requirements of the crop in this respect are very small, and but a few pounds of any lime compound per acre would suffice for any crop.

Lime is one of the most abundant substances. It has been estimated that not less than one-sixth of all the rocks on the surface of the earth are lime-stones, and that the element Calcium composes about one-sixteenth of the solid crust of the earth. From this it will be gathered that lime is sufficiently diffused in nature to supply the needs of most plants for this food. Indeed there are few arable soils so poor in lime as not to contain far more than would supply all the demands of crops for years; yet it may happen that in some sandy regions, and in soils that have resulted from the decomposition of certain substances, slates and other rocks poor in lime that there would be a deficiency of lime for serving as nourishment for plants; but in such cases the deficiency of other plant food would be more marked, and in supplying them from the sources ordinarily available the lime would be supplied in abundance for the food requirements of the crops.

The action of lime on soils may be considered under three heads: 1st—Chemical action, 2nd—Physical action, and 3rd—Supplying a plant food. It is only the first and second divisions that have much importance for the Maryland farmer. Lime is termed an indirect fertilizer in consequence of the little need of it as a plant food, and because of its benefits being derived from its chemical and physical action on the soil. Different kinds of lime have, in the main, much the same kind of action, but they differ in the degree and avidity of the inaction.

CHEMICAL ACTION OF LIME ON SOILS.

One of the most important chemical changes brought about in a soil through the action of lime is the decomposition of minerals, particularly the disintegration of refractory silicates. Such action as this would generally be produced more easily by caustic or quick-lime than by any other form. Lime materially aids in the formation of double silicates of alumina, which have an important influence on the fertility of the land. Double silicates of alumina may be described as silicates of alumina in which part of the alumina is replaced by lime, soda, potash or ammonia. Most farmers are aware that ammonia is more valuable than potash, whilst potash is more valuable than soda and soda is more valuable than lime The double silicates of alumina, when once formed seem to recognize this, and exercise a similar order of preference. If a double silicate of alumina and lime exist in the soil and should be brought in contact with soda, some of the lime will be given up and soda will replace it, resulting in a silicate of alumina and soda. The presence of the lime will not enable it to replace the soda, as the silicate of alumina prefers the soda to the lime. If, however, potash be added, the soda is given up and potash taken into the combination, because the silicate of alumina prefers the potash. But if ammonia comes within the influence of this compound it will replace either the lime, soda or potash, and silicate of alumina and ammonia would be formed. These double silicates are in such shape as to be lost from the soil by leaching, yet are in a readily available condition for plants. From this it will be seen that it is desirable to promote the formation of double silicates, and caustic lime seems to have a decided action upon clays in starting and bringing about the formation of this most desirable class of bodies.

Lime and Potash.—Lime has not only the effect of ading in the formation of unions of potash which will be held in the soil, but it also has the ability to liberate potash from combinations which are locked up and unavailable to plants. This is particularly marked when lime is applied to land containing fragments of feldspar. Gypsum is particularly useful in rendering potash available, and the sulphate of lime in dissolved phosphates often have an indirect value in this way.

Lime also favors the production of nitrate of potash in the soil. This is particularly true when lime is used on soils receiving considerable stable manure. The process and changes involved are exactly similar to those which have been employed in many places for the production of nitrate of potash (Nitre) for use in the manufacture of gunpowder, and for which a prize was awarded by the French Government to Mons. Thouvenel in 1776.

Lime and Organic Compounds.—Lime hastens the decomposition of organic matter and inert nitrogen compounds of humus in the soil, and promotes the formation of ammonia and nitrate compounds from the same. It also, as has been seen above, aids in the formation of compounds not easily removed from the soil. Lime promotes nitrifying ferments and makes possible their existence in many cases that would be impossible without its presence.

Lime produces particularly good results if applied after using green manures, as it acts chemically and unites with some parts of the organic matter and leaves the remainder in a disorganized condition which rapidly decomposes. It is, perhaps, this tendency to destroy organic matter that makes the frequent use of lime pernicious. All evidence teaches us that lime is no substitute for manure but only a reinforcement of it. No doubt much land has been reduced to the verge of sterility by applying lime continually until all the organic matter has been used up. Such procedure is probably responsible for the old proverb, "Lime enriches the father but beggars the son."

Lime and Phosphoric Acid.—If a soil contains much phosphoric acid combined with iron and alumina which is relatively inert, an application of lime will change it into a form available to plants. Lime applied to soils which have received or will receive applications of dissolved phosphates, will not produce any harmful results or cause a loss of the phosphoric acid. It may hasten the reversion of the soluble phosphoric acid, but the phosphoric acid will still be in an available condition. In the average soil this reversion takes place any way within twenty-four hours after applying the phosphate.

Lime Corrects Acidity.—Most cutivated soils possess a slightly acid reaction. This is generally due to decomposition of the remains of plants in the soil forming organic acids. On wet soils this condition is more noticeable than on dry soils. The sour humus and organic acids are not only unfavorable to the growth of nitrifying ferments and the root tubercles of leguminous plants but also are likely to dissolve iron and other compounds which are poisonous to microbes and crops. Water-culture experiments have shown that slightly acid solutions are favorable to the growth of plants, and while most soils possess this character to a slight degree, yet any excess of soluble acid in the soil would be highly detrimental. While most of our cultivated crops seem to need a slight acidity, it is probable that they have the ability to create this condition to a sufficient degree through the medium of the solutions sent out by their roots. This being the case, it would seem that the aim should be to keep soils in a neutral or slightly alkaline condition so as to favor the growth of root tubercles of the legumes and the desirable soil ferments.

Liming is excellent for correcting any excess of acidity, and is probably the most effective and economical substance for bringing about these other desirable conditions.

Physical Results of Liming Soils.

The many chemical changes brought about by the action of lime on soils result in producing physical changes which give soils new mechanical characteristics. Lime has the power of changing the physical properties of a clay soil and making it more friable and easily cultivated, and putting it in a condition so that water may pass more freely through it. This will make it less susceptible to extremes of dry or wet weather, and make it a good home for the roots of the plants. The action of lime on sandy soils may be said to be the reverse of that on clay soils; that is, it has a cementing action, making such soils stick together and in such a condition that they will hold more water and not dry out so rapidly.

The changes are brought about by what is termed the "flocculation" of the clay and organic particles. It has been found that one (1) part of lime has the power to flocculate and clear 10,000 parts of a turbid liquid, so that it can be readily understood that an application of one ton (35 bushels) of lime would have marked effect on an average soil to the depth of six inches which weighs approximately 900 tons.

Other Effects of Lime.

As has been stated, applications of lime produce a beneficial effect in giving a favorable medium for the growth of nitrifying organisms and of the root tubercles on the leguminous plants (particularly the clover). Lime is also sometimes applied to prevent the "Club-foot" of cabbage, celery and of certain root crops. It is sometimes used to destroy larvæ, slugs and worms, but experiments do not bear this out and it is doubtful if it has such an effect. Applications of lime are also supposed to favor the development of certain injurious and undesirable conditions such as the scab disease in potatoes.

EFFECTS OF LIME ON VARIOUS PLANTS.

The experiments conducted by the Rhode Island Experiment Station have resulted in the following classification of plants according to their action with reference to lime:

TABLE XVII

Giving approximate Effects of Lime on various Plants.

Plants Benefited by Lime.	Plants Indifferent to Lime.	Plants Injured by Lime.
Spinach, Lettuce, Beets, Okra. Salsify, Celery, Onions. Parsnips, Cauliflower, Cabbage, Cucumbers, Egg Plants, Cantaloupes, Asparagus, Kohl-rabi, Dandelion, Swedish Turnip, Pepper, Pea, Peanuts, Tobacco, Sorghum, Alfalfa, Clover, Barley, Wheat, Oats, Timothy, Ky. Blue Grass, Seed Fruits, Stone Fruits.	*Corn, Millet, Hungarian Millet, Golden, Rye. Potatoes, Carrots, R. I. Bent Grass, Red top Grass.	Watermelon, Serradella, Blue Lupine, Sheep Sorrel.

*Experiments at this Station have shown applications of lime to corn to give marked increase in yield.

From the list it will be seen that most all of the crops commonly grown in Maryland, are benefited by application of lime.

TIME OF THE YEAR TO APPLY LIME.

The fall is generally considered the best time to apply lime, but moderate application may be made whenever the farmer finds it convenient to perform the work. With the conditions generally prevailing in this State it will usually be found most convenient to haul the lime in the winter and apply it in the spring in order to get it harrowed into the land. Much of the fall grain is seeded on corn ground and this land is not plowed up or in shape to apply the lime advantageously at that season.

It will be noted that most of the experiments reported in this bulletin are with spring applications.

How Much and How Often to Apply the Lime.

The quantity of lime applied varies considerably in the various sections and at various times. This has probably been due in a large measure to the cost of lime and the relative distance it must be hauled. Recent observations seem to indicate that it is better to apply small quantities and make the applications at frequent intervals rather than apply very large quantities at one time. The old practice of putting 100 bushels or more per acre is seldom practiced now. The kind of soil to which the application is made makes it necessary to vary the quantity. It is now pretty well recognized that on poor soils and on sandy soils, the quantity applied at one time should be small. The quantity and frequency are points that are under test at this Station. See the results in Tables II to VII, pages 2 to 9.

Method of Applying Lime.

There is probably considerable energy wasted and money lost in the manner in which lime is applied.

In the first place it should be remembered that the tendency of lime is downward in the soil, so it should always be applied at the surface and never plowed under. In the second place it should be remembered that the lime, when in its caustic or quick state, has the most power in producing chemical and physical changes in the soil. For this reason the aim should be to get the lime into the soil in its active state, and have it thoroughly incorporated in the soil before it has had a chance to lose any of its active principles. See results on another page. With this idea in mind, lime should be slaked by means of water, and, as soon as in a powdery state, be spread over the land and at once harrowed in, to thoroughly incorporate it in the soil, lime should not be allowed to *"air"* slake, as by so doing it absorbs considerable carbonic acid from the air and some of it is changed back to the carbonate, the chemical form in which it existed before burning and consequently some of that which was paid for in burning is lost. Lime put on small or large piles to slake should be covered with earth to keep it out of contact with the air while slaking, and, as soon as it has come to a powdery condition, it should be spread on the land and harbowed in.

It will generally be found more economical to haul water to apply to the lime and slake it at once rather than cover with earth.

Slaking with water would be a more economical method than to lose part of the value of the lime through air slaking.

When it can be avoided do not apply lime on top of the land with the idea that the rains will dissolve it and carry it into the soil, for, in the first place the rains may not come until after some lapse of time and much of the lime will have returned to the carbonate; and, in the second place, it takes 700 pounds of water to dissolve one pound of lime and that amount of rain could not be depended upon.

Recently lime has been put on the market in a powdered caustic state so that it can be applied to the land with a grain drill or lime-spreader or by most manure spreaders and get it thoroughly incorporated with the soil while it is still in the quick state which, theoretically, should be the best way. This kind of lime also affords an opportunity to apply small quantities and get it more evenly distributed than is possible with a shovel.

The lime spreaders or the lime attachments which come with most manure spreaders will be found very valuable for spreading slaked lime and particularly so when only small quantities per acre are to be used.

The system of putting lime in small (one bushel and one-half bushel) piles all over the field and allowing it to slake before spreading is not to be recommended, as it usually will be found not to be the easiest and most economical means of application; but in case this method of doing the work is desired the following table of distances may be found helpful to many.

TABLE XVIII.

Showing distances apart that 1 *bushel and* ½ *bushel piles of Lime should be placed to cover an Acre with a given quantity.*

Bushels per Acre.	One Bushel Piles	One-half Bushel Piles
	Number of Feet Square.	
20	46½	33
25	41¾	29½
30	38	27
40	33	23¼
50	29½	20¾
60	27	19
70	25	17¾
75	24¼	7
80	23½	16½
90	22	15½
100	20¾	14¾
		1

When lime is applied in this way care should be taken to never allow it to lay until it becomes mucked or to spread it when it is wet.

How to Determine the Need for Lime.

There have been numerous methods proposed for determining the need for lime and the probable quantity required; none of them are very reliable and all take more or less skill in their application. The most reliable test is evidenced by the crop, but this takes considerable time. Probably the easiest test is the use of blue litmus paper for testing the acidity of soils, and if it turns red rapidly it will generally indicate the need for lime. The blue litmus paper test is very simple; it is made by bringing a piece of blue litmus paper in contact with the moistened soil and observing the intensity and rapidity of the redness thus produced.

The general characteristics of the land as to its derivation can not be taken as a sure indication of the lack or supply of lime. It is not infrequent to find that in lime-stone regions and on the so-called lime-stone soils that applications of lime produce most marked results. This is due to the fact that the lime of lime-stone soils has been removed in a great part through prolonged decay and the dissolving action of the carbonated waters. This, not infrequently, leaves such soils so siliceous or ferrugenous as to be quite barren, and of a nature to be benefited by an application of lime. Throughout the areas occupied by the Trenton Lime-stones in Maryland, nearly every farm has, in years past, had its quarry and lime-kiln for fitting and supplying lime once more to soils that had been so thoroughly leached as to render them lean and poor.

The Occurrence and Composition of the Sources of Lime in Maryland.

Maryland is well supplied with lime for agricultural purposes. It is not only abundant, but quite generally and widely distributed.

The source of lime in Maryland may be divided into three general classes: first, lime-stone: second, marls: third, shells. The lime-stones occur widely distributed throughout the western part of the State, and the marls throughout the tide-water areas of Southern Maryland and the Eastern Shore. The shell, derived mostly from the oyster. is burned into lime and used more or less in all parts of the State, but most generally in the tidewater sections.

In studying the sources of lime available in this State eighty-six samples, representing the various deposits, were furnished to us by Dr. Wm. B. Clark, State Geologist, which were duplicates of those procured in making the geological survey. These samples were analized and the results are found in Table XIX.

In addition to the report on the analyses of the samples furnished by the Survey, will be given the analyses of those that have come to this Station from time to time during the past eighteen years, together with a compilation of a few of the analyses of the Maryland limes and lime-stones which have come to our attention. These samples, in some instances, have been sent by the manufacturers and in others by the users of the lime, hence the Station can only report on the quality of the sample received, and can, in no degree, vouch for the authenticity of the sample.

By referring to the analyses as given in the tables, it will be seen that limestone of good quality for agricultural purposes occurs quite widely and generally distributed in Maryland, which, together with the marls and abundance of oyster shells in the bay and tide water sections, puts lime within easy reach for all. The variation in the quality of lime-stones in this State makes it possible to procure any grade desired, and where special advantages are obtained on some soils through the use of pure lime, magnesium lime or alum lime, they can be taken advantage of, and all at about the same cost. A study of the quality of these various deposits makes it evident that where the simple effect of the lime is desired, that it could be obtained by using some of the local sources of lime and thus save much that is now being paid for freight in transporting lime from a relatively distant quarry.

There are few states where the farmers are so fortunate as to have some source of lime at almost every door, and there is no doubt but that it could be used advantageously by many, if applied judiciously, who are not now availing of this means of improving the fertility of their lands.

TABLE XIX.

Description and Composition of Samples of Limestone furnished by the Maryland Geological Survey.

T. MALCOLM PRICE, *Analyst.*

(Figures indicate per cents, or pounds in 100 pounds.)

Laboratory No.	Survey No.	Geological Classification.	Locality.	Insoluble matter, sand, silica, etc.	Iron and Aluminium Oxides.	Calcium (lime) Carbonate ($CaCO_3$)	Magnesium Carbonate ($MgCO_3$)	Total.
2140	8	Archean	Carroll county......................	0.43	9.00	89.99	1.02	100.14
2141	4077	Cambrian	Scaggs Quarry, 1 mile west of Highlands, Howard county............	48.39	14.24	35.66	1.96	100.25
2142	4078	"	Wm. Federline's lime kiln, 1½ miles west of Highlands, Howard county	10.13	10.94	75.67	3.70	100.34
2143	4642	Carboniferous	West of George's Creek, on the north side of Carlos Branch Railroad, 3 miles south of Frostburg, Allegany county.................	3.89	12.16	83.57	1.87	99.89
2144	4683	"	West of Lonaconing, near the Allegany-Garrett county line, 105 feet above the "Gib vein" Coal Mine, near the "Old Spring" at the new furnace shaft south of Koonts run.	4.37	19.62	74.70	2.01	98.69
2145	4685	"	Mouth of Stony Run, on the Potomac, 2 miles east of Western Port, Allegany county.................	3.65	8.44	85.87	1.30	99.26
2146	4	"	Gerrenger & Sugarhart's Quarry, near Friendsville, Garrett county.	13.65	5.44	79.16	1.21	99.46

2147	4698	"	On the west side of George's Creek & Cumberland Railroad; ½ mile west of Vale Summit, in bed of ravine. Allegany county.........	1.44	6.94	90.40	0.99	99.79
2148	4641	"	From old opening on roadside; 1 mile north of Frostburg, near N. Y. Mine opening, Allegany county..	25.01	48.92	7.83	18.70	100.46
2149	3	"	Offut's Quarry, 5 miles south west of Oakland, Garrett county......	13.46	12.48	72.92	1.15	99.91
2150	4693	"	Mouth of Stony Run on the Potomac. 2 miles east of Western Port, Allegany county.....................	11.52	3.37	74.48	10.99	100.36
2151	4676	"	In east bank of George's Creek, in town of Barton, Allegany county, only a few inches thick...........	20.22	25.54	51.10	3.40	100.26
2152	4643	"	Top stratum of lime-stone in C. & P. R. R. cut; just south of crossing, near pumping shaft; 3 miles south of Frostburg, Allegany county...	10.63	13.18	73.73	1.61	99.15
2153	4715	"	On Potomac Gravity Plain. 1½ miles east of Barton; about 80 feet above bottom of Fairfax formation, Allegany county............	9.86	4.90	83.69	1.96	100.41
2154	4709	"	Near top of Fairfax formation; on W. S. Trimble's farm, south-east Mt. Savage Station, Allegany county..	22.03	51.16	24.80	1.88	99.87
2155	2	"	Lime kiln at Crabtree Station on B. & O. R. R. near Frankville, Garrett co.	8.57	2.38	88.73	0.86	100.54
2156	4667	"	Mouth of Stony Run, on the Potomac. 2 miles east of Western Port, Allegany county.....................	5.11	3.56	89.08	3.17	99.92

TABLE XIX—*Continued.*

Laboratory No.	Survey No.	Geological Classification.	Locality.	Insoluble matter. sand, silica, etc.	Iron and Aluminium Oxides.	Calcium (lime) Carbonate ($CaCO_3$)	Magnesium Carbonate ($MgCO_3$)	Total.
2157	4928	Chert Beds	North Branch, Allegany county.....	53.37	6.24	37 74	2.87	100.22
2158	7	Cockeysville Marble	Cockeysville, Baltimore county	9.79	5.62	70.64	14.61	100.60
2159	4629	Devonian	30 yards east of church on William's Road; about two miles east of Cumberland; 40 feet above the Romney-Monterey Contact................	30.37	61.62	5.19	2.80	99.98
2160	4639	"	On county road, near spring on fork of road near south end of Warrior Mountain, west of Oldtown, Allegany county......................	89.80	2.16	7 14	1.07	100.17
2161	4723	"	West side of W. Va. Cent. R. R., in cut 20 yards north of Bridge across the Potomac. About 1 mile north of Keyser, W. Va. but in Allegany Co.	21.78	4.30	69.08	3.81	98.97
2162	3036	Greenbriar	Barrelville, Washington county.....	5.24	1.98	84 58	7.49	99.29
2163	35	"	South of Negro Mountain, Garrett Co.	20 95	41.10	37.35	0.91	100.36
2164	4103	"	Offut's Quarry; 6 miles north of Oakland, Garrett county..........	17 00	2 74	62.12	15.75	99.61
2165	8000	"	Findley's Quarry, Piney Run, Garrett county......................	4 47	2.70	93.09	6.38	100.28
2166	3057	Lewistown	Cumberland, Allegany county......	3 51	3.30	90.48	2.37	99.60

2167	3055	"	Miller's Quarry, Allegany county...	1.83	2.40	92.96	2.83	100.02
2168	3059	"	Mrs. M. Rowan....................	3.47	2.64	88.85	4.36	99.32
2169	3058	"	C. F. Thrasher.....................	3.75	2.58	82.41	11.01	99.75
2170	4110	"	Hancock, Washington county.......	5.97	12.94	79.42	1.13	99.46
2171	9	"	Pinto, Allegany county.............	20.90	33.14	36.96	8.62	99.62
2172	10	"	" " "	17.91	6.14	73.13	2.48	99.66
2173	11	"	" " "	34.01	5.60	59.03	1.81	100.45
2174	3	"	Clement vein No. 3 Clement Works, Pinto, Allegany county...........	26.43	8.18	52.35	12.81	99.79
2175	4	"	Near top layer at Rawlins kiln, Potomac, W. Va....................	1.20	3.60	90.69	4.69	100.18
2176	4154	"	Flintstone, Allegany county	5.57	4.43	84.32	5.93	100.25
2177	4914	"	Cut in B. & O. R. R. at Clement Mill, Pinto, Allegany county......	14.50	4.40	79.41	1.02	99.33
2178	5	"	Potomac Station, Allegany county..	16.33	14.48	62.64	6.17	99.52
2179	2	Monterey	Limey layers near top of Oriskay S. S., Cumberland, Allegany county.	57.49	4.40	26.88	10.79	99.56
2180	7095	Newark	Lime stone *breccia*, Tyson's Quarry, Mt. Pleasant, Frederick county...	5.75	8.74	76.78	9.15	100.42
2181	4645	Permian	On east side of Cumberland & Pa. R. R.; about 250 yards north of Frostburg, Allegany county...........	32.41	11.82	53.42	2.33	99.48
2182	4139	Shenando'h	Cavetown, Washington county......	12.00	4.42	83.10	0.93	100.45

TABLE XIX—*Continued.*

Laboratory No.	Survey No.	Geological Classification.	Locality.	Insoluble matter, sand, silica, etc.	Iron and Aluminium Oxides.	Calcium (Lime) Carbonate ($CaCO_3$)	Magnesium Carbonate ($MgCO_3$)	Total.
2183	4151	Shenandoah	Sharpsburg, Washington county....	0.70	2.84	91.32	5.05	99.91
2184	6	"	Leitersburg, Washington county....	3.53	3.42	90.01	2.13	99.69
2185	3056	"	Leopold's Quarry..................	1.51	5.90	89.07	3.25	99.73
2186	4145	"	North edge of Flintstone, Washington county........................	21.84	12.08	64 33	1.76	100.01
2187	1	"	Keedysville, Washington county....	0.63	6.30	90.92	2.49	100.34
2189	4150	"	On C. & O. Cent. Canal, 4 miles south of Sharpsburg, Washington county	2.14	6 70	89.82	1.10	99.76
2188	4127	"	Southeast of Leitersburg on road near creek.......................	4.17	8.04	81.73	6.62	99.56
2190	4141	"	Cavetown, Washington county......	20.32	8.60	66.80	3.36	99.08
2191	7006	"	Cramer's Quarry, Mt. Pleasant, Frederick county................	11.13	8.00	78 62	2.60	100.05
2192	7115	"	Mountview, Frederick county.......	4.99	6.28	84 14	3.97	99.38
2193	7104	"	C. J. Keller's Quarry, Buckstown, Frederick county................	33.36	6.65	57.41	3.02	100.39
2194	7070	"	Union Bridge, Carroll county.......	0 56	1.50	97.14	0.81	100.01
2195	7071	"	" " "	0.50	2.94	95.44	1.33	100.21

2196	7073	"	" " "	0.43	4.28	94.10	1.64	100.45
2197	7102	"	Frederick City, Frederick county...	1.65	8.26	90.23	5.19	100.33
2198	7021	"	H. Cramer's Quarry, Mt. Pleasant, Frederick county................	9.06	10.92	78.56	2.07	100.61
2199	7108	"	D. Roddy's Quarry, Thurmont, Frederick county......................	0.52	4.54	92.67	1.80	99.53
2200	7106	"	D. Roddy's Quarry, Thurmont, Frederick county......................	5.66	0.74	93.05	1.84	101.29
2201	7102	"	Mountview, Frederick, Frederick co.	4.64	0.14	93.14	1.39	99.31
2202	4199	"	Yost's Quarry, west of Hagerstown, Washington county..............	4.99	0.44	91.03	3.28	99.74
2203	4180	"	Deitrich Quarry, west of Hagerstown, Washington county.........	9.46	4.04	62.10	4.63	99.37
2224	7098	"	Barrett's Quarry, Woodboro, Frederick county......................	2.33	10.10	81.57	5.60	99.60
2225	3056	"	Leopold's Lime Kiln. This is a duplicate in number and description to No. 2185, but different in appearance........................	1.93	5.66	83.35	8.50	99.44
2204	4175	Upper Silurian	A small lime kiln on National road, 4 miles northeast of Cumberland, Allegany county.................	0.75	0.16	92.19	7.38	100.38
2205	4618	Top of Silurian	Near the canal at south end of Nicholas mountain, at the Louistown-Monterey contact, Allegany co....	10.68	6.98	79.89	2.82	100.35
2206	4125	Silurian	Murray lime kiln, 2½ miles west of Hancock, near the National road.	12.38	3.30	83.59	0.69	99.97

TABLE XIX—*Continued.*

Laboratory No.	Survey No.	Geological Classification.	Locality.	Insoluble matter, sand, silica, etc.	Iron and Aluminium Oxides.	Calcium (lime) Carbonate ($CaCO_3$)	Magnesium Carbonate ($MgCO_3$)	Total.
2207	4153	Silurian	Western Maryland Railroad Quarry; 2½ miles west of Williamsport, Washington county...............	4.04	9.80	77.10	8.38	99.22
2208	4128	"	On roadside near Leitersburg, Washington county.....................	5.42	4.20	89.61	0.07	99.30
2209	4143	"	North suburbs of Funkstown, Washington county.....................	0.62	8.08	85.82	5.88	100.40
2210	4131	"	Roadside near Leitersburg, Washington county......	4.08	4.70	82.08	9 71	100.52
2211	4111	"	At side of National Road, in western suburbs of Hancock, Washington county	3.80	4.00	89.53	2.42	99.75
2212	4155	"	Yost's Quarry, about 5 miles west-northwest of Hagerstown, Washington county..................	0.80	4.64	92.19	2.84	100.47
2213	4504	"	From out crop on National Road in eastern suburbs of Flintstone, Allegany county.....................	1.88	5 98	89.64	2.42	99.72
2214	4148	"	Near C. & O. Canal; 4 miles south of Sharpsburg, Washington county	1.79	3 46	83.33	11.50	100.08
2215	4177	"	Byer's Quarry, in northern suburbs of Hagerstown, Washington county...........................	3.65	4.44	91.92	0.25	100.08

2216	4179	"	Yost's Quarry, (?) miles west of Hagerstown	2.39	1.47	92.74	2.57	99.17
2217	1	"	Mullen's lime kiln, in northeast part of Cumberland, Allegany county	12.27	12.88	73.46	0.86	99.47
2218	4154	"	So-called "Black Marble," 1½ miles south of Flintstone, Allegany Co.	5.92	12.98	79.92	0.36	99.18
2219	4500	"	East side of Flintstone Creek, ½ mile north of Flintstone, Allegany Co.	7.33	9.18	83.60	0.22	100.33
2220	4152	"	Railroad cut, 2 miles north of Keedysville, Washington county	3.21	4.12	91.85	0.74	99.92
2221	4180	"	Dietrick's Quarry, (?) miles west of Hagerstown, Washington county	11.00	8.20	77.51	3.25	99.96
2222	4140	"	Limestone Quarry in - Cavetown, Washington county	0.74	6.98	91.01	0.74	99.47
2223	3065	Spencer	Pinto, Allegany county	0.79	9.03	87.03	2.60	99.35

TABLE XX.

Description and Composition of Miscellaneous samples of Limestone sent to the Experiment Station for Analysis.

H. J. PATTERSON, Analyst.

(Figures indicate per cents, or pounds in 100 pounds.)

Laboratory No.	Description of Sample.	Sent by:	Insoluble matter, sand, silica, etc.	Iron and Aluminium Oxide.	Calcium (lime) Carbonate, ($CaCO_3$)	Magnesium Carbonate, ($MgCO_3$)	Undetermined.	Total.
802	Gray Limestone.......... Lime Kiln, Maryland...	M. J. Grove Co., Lime Kiln, Maryland............	0.31	0.14	93.49	5.95	....	99.99
803	Blue Limestone..........	M. J. Grove Lime Co., Lime Kiln, Maryland............	3.90	0.36	93 26	2.50	....	100.02
1042	Pulverized Marble........	Beaver Dam Marble Co., Cockeysville, Maryland..........	2.33	1.55	52.33	43.69	0.08*	99.98
1542	Limestone................	E. H. Brown, Johnsville, Md......	7.15	11.90	51.61	27.45	1.89†	100.00
1563	Micaceous Gray Limestone	Mrs. Hopkins, Highlands, Md.....	13.60	5.15	77.82	3.19	0.24†	100.00
1565	Limestone................	E. W. Adams, Clarksville, Md.....	13.00	6.00	50.00	31.00	....	100.00
1567	Limestone................	T. T. Hershberger, Frederick, Md.	10.17	5.53	78.12	6.18	....	100.00
1879	Mixture of blue, dark-gray and light-gray stone....	J. W. LeGore, Woodsboro, Maryland...........	0.50	0.60	98.39	0.51	....	100.00
1991	Gray Limestone..........	Aaron Wood, Woodsboro, Md......	5.30	9.80	53.57	31.33	....	100.00
2116	Limestone................	J. N. Clery, Frederick, Md........	6240	7.60	30.00	0.00	....	100.00
2122	Lightest-gray Limestone..	J. W. Stimmel, Walkersville, Md..	4.73	1 40	93.51	0.30	0.06	100.00
2123	Gray Limestone..........	J. W. Stimmel, Walkersville, Md..	4.31	0 90	81.79	13.00	....	100.00
2127	White Limestone.........	Kerr Bros. Co., Wrightsville, Pa..	0.49	1.80	94.53	3.18	....	100.00

2128	Gray Limestone..........	Kerr Bros. Co., Wrightsville, Pa..	0.26	3.10	93.32	3.32	....	100.00
2226	Gray Limestone..........	Joshua C. Miller, Boonsboro, Md...	1 26	10.63	88.07	0.00	0.07	100.00
2227	White Limestone.........	Joshua C. Miller, Boonsboro, Md...	1.95	9.92	83.39	3.19	0.55	100.00
46	Oyster Shells............	Sample analyzed by J. R. Laughlin	1.15	1.00	94.75	0.00	2.44†	......
47	" "	" " "	1.12	1.31	92.94	0.00	3.79†	......
	Blue Limestone...........	James W. Smith, Walkersville.....	0.89	0.50	98.00	0.66	....	100.05
	Red Limestone...........	James W. Smith, Walkersville.....	1.44	3.60	64.70	30.49	....	100.23
2299	Jamaica Limestone.......	A. R. Mitchell, Hereford..........	0.45	4.76	71.10	23.89	....	100.20
2517	Marble	B. Gardenhouse, Smithsburg......	1.16	2.44	92.03	4.72	....	100.35
2518	White Limestone.........	L. J. Kemp, Woodstock...........	2.54	0.76	96.07	Trace	....	99.37
2519	Gray Limestone..........	L. S. Kemp, Woodstock...........	5.56	5.14	76.60	13.05	....	100.35
2656	Blue Stone...............	J. S. Norris, Md. & P. R. R.......	0.60	19.78	49.80	29.74	....	99.92
2766	Limestone No. 1..........	E. R. Allen, Union Bridge.........	1.16	0.86	88.92	8.05	1.01	100.00
2767	Limestone No. 2..........	E. R. Allen, Union Bridge.........	0.16	1.25	60.81	36.51	1.27	100.00
2768	Limestone No. 3..........	E. R. Allen, Union Bridge.........	0.98	0.49	94.52	4.21	....	100.20
2788	Blue and Gray Limestone.	C. A. Rogers, Buckeystown........	0.17	0.26	98.16	0.69	....	99.28
2816	Limestone...............	J. S. Norris, Md. & Pa. R. R......	6.94	1.04	87.52	4.50	....	100.00
2860	Limestone...............	M. J. Grove, Lime Kiln............	0.85	0.72	58.73	38.92	....	99.22
2880	Limestone...............	J. W. Carder, Oldtown...........	8.55	2.30	47.16	41.38	....	99.39
2881	Limestone...............	J. W. Carder, Oldtown...........	4.47	0.20	73.90	2.74	8.69	100.00

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*Water in the marble dust. ‡Potash calculated as K_2O.

†Water—These samples had 0.10 and 0.24 per cent. phosphoric acid, respectively.

TABLE XXI.

Composition of miscellaneous samples of Maryland Limestone.

(Analyses procured from various sources).

(Figures indicate per cents., or pounds in 100 pounds.)

Description of Sample.	Analyst.	Insoluble matter, sand, silica, etc.	Iron and Aluminium Oxides.	Calcium (lime) Carbonate, ($CaCO_3$)	Magnesium Carbonate, ($MgCO_3$)	Undetermined.	Total.
Cockeysville Marble	Schneider	5.57	0.40	51.90	42.60	.....	100.47
Cockeysville Marble	Whitefield	0.44	Trace	54.87	43.84	.....	99.15
Cockeysville Marble	Higgins	2.33	0.00	52.33	43.70	.....	98.36
Texas Limestone	Williams	2.00	0.00	93.00	5.00	.....	100.00
Washington Co. Limestone, from Dr. T. Maddox	Dr. Higgins	5.80	0.10	90.70	3.18	0.12	......
" " " "	"	0.60	0.00	98.58	0.87	0.00	......
" " " David Zellers	"	0.25	.....	96.75	2.75	0.25	......
" " " B. J. Beyers	"	2.40	0.60	94.76	2.25	Trace	......
" " " I. E. Davis	"	3.00	0.27	53.94	42.79	Trace	......
" " " "	"	0.70	0.00	54.93	44.35	Trace	......
" " " George Heyser	"	2.00	0.30	95.00	2.60	0.10	......
" " " John T. Mason	"	2.00	0.64	56.50	30.80	0.00	......

Washington Co. Limestone, from James Biays.....	" ..	0.60	0.00	98.53	0.87	0.00	......
Specimen from head of Pleasant Valley...........	" ..	6.00	0.20	90.70	3.00	0.00	......
" " Beaver Creek............	" ..	0.20	0.10	97.00	2.50	0.30	......
" " near Williamsport........	" ..	0.50	0.10	98.50	0.80	0.10	.....
" " Carroll county:							
White limestone from Unionville..................	" ..	0.50	.....	99.50	0.00	.....	......
Dark gray Limestone from Rinehart.............	" ..	20.20	.....	68.30	11.50	.....	......
Dark gray Limestone with white veins...........	" ..	0.70	.....	98.80	0.50	.....	......

TABLE XXII.

Description and Composition of Miscellaneous Samples of Burned (Quick) Lime, sent to the Experiment Station for Analysis.

H. J. PATTERSON, Analyst.

(Figures indicate per cents, or pounds in 100 pounds.)

Laboratory No.	Description of Sample.	Sent by:	Insoluble matter.	Iron and Aluminium Oxides.	Lime (CaO)	Magnesia (MgO)	Undetermined.*	Total.
1043	Woodsboro Lime..........	W. H. Biggs & Bro., Rocky Ridge, Md..............................	1.85	3.10	91.10	0.92	3.03	100.00
1044	Cavetown Lime..........	W. H. Biggs & Bro., Rocky Ridge, Md..............................	2.75	4.83	73.90	17.94	0.58	100.00
1543		Adam Diehl, Jr., Walkersville, Md.	1.35	0.75	83.40	0.72	13.78	100.00
1723	Oyster Shell Lime.......	Purchased in Baltimore City........	.....	.....	61.75	.....	.....	......
1724	Stone Lime.............	" " Silver Spring, Md.....	.....	......	95.25	.....	.....	......
1725	Gas House Lime.........	" " Baltimore City........	.....	.....	42.50	.....	.....	......
1732	Wrightsville Lime.......	Edward Boynton, Port Deposit, Md.	0.15	1.50	67.44	30.91	.....	100.00
1790	Grove's Lime..........	P. C. Prough, Freedom, Md........	25.00	2.40	47.10	25.16	0.34	100.00
1791	Black's Lime...........	" " "........	19.71	7.00	69.80	2.02	1.47	100.00
1848	LeGore's Combination Lime..................	W. O. Thomas, Sudlersville, Md....	1.63	1.20	96.00	1.08	.....	100.00

1949	Frederick City Lime Co's Lime	Frederick City Lime Co., Frederick, Md	7.70	2.55	84.89	4.86	.....	100.00
2019	Aaron Wood's Lime	Aaron Wood, Woodsboro, Md	1.06	2.40	90.00	1.00	4.54	100.00
2130		Benjamin F. Rash, Worton, Md	6.69	9.30	82.92	0.40	1.61	100.00
	Ground Stone Lime	Maryland Agri. Experiment Station	2.60	8.26	82.06	2.94	3.14	100.00
	Glasshouse Lime	" " " "	6.33	9.56	83.11	0.35	0.65	100.00
	Howard County Lime	Dr. Tatum, Ashton, Md	6 02	13.30	75.40	2.00	3.28	100.00
2729	Wood-burnt Lime	B. D. Biggs, Thurmont	24.51	17.90	50.40	6.75	0.44	100.00

*Mostly water and carbonic acid gas.

TABLE XXIII.

Description and Composition of Samples of Quick Lime.

SAMPLED AND ANALYZED BY DR. H. B. MCDONNELL AND F. P. VEITCH.

(Figures indicate per cents, or pounds in 100 pounds.)

Laboratory No.	Description of Sample.	Sample taken at	Insoluble matter, sand, silica, etc.	Iron and Aluminium Oxides.	Lime (CaO)	Magnesia (MgO)	Water and Carbon-dioxide.	Total.
1	Gas Lime, fresh..........	Canton, Baltimore county, Md...	8.54	2.15	42.44	0.34	44.94	100.00
2	" " Weathered 1 year	" " " " ..	4.54	1.11	34.81	0.24	57.93	100.00
3	" " fresh..........	" " " " ..	4.41	1.47	37.50	0.29	55.41	100.00
4	" " "	Bayard Street, Baltimore. Md...	8.20	1.66	41.60	0.33	46.89	100.00
5	" " Weathered 10 yrs.	" " " " ..	8.70	1.65	30.83	0.20	57.70	100.00
6	Oyster Shell Lime, slaked fresh..................	" " " " ..	8.99	1.84	54.62	0.43	33.27	100.00
7	Oyster Shell Lime, fresh burned................	H. C. Pearson Packing Co., Baltimore, Md..................	5.79	2.71	84.58	0.55	5.92	100.49
8	Stone Lime from Texas, Md....................	Texas Lime Co., Baltimore, Md.	3.32	1.09	86.17	5.82	3.42	100.00
9	Stone Lime Crucible burned, select..........	Sent by the Standard Lime Co., from Engles, W. Va..........	0.22	0.44	98.06	0.50	0.67	100.00
10	Stone Lime from Frederick	Washington Grove,..............	18.96	3.14	69.18	15.77	2.95	100.00

11	Stone Lime from Lime Kiln	Boyds, Maryland	11.65	2.80	62.34	19.69	3.52	100.00
12	" " " Buckeystown	Mt. Airy, Woodbine and Derwood, Md	12.08	2.95	74.48	9.70	1.27	100.45
13	Stone Lime from LeGore.	Legore	6.27	1.86	87.09	4.39	0.81	100.42
14	" " " Martinsburg, W. Va*	Rockville and Sykesville, Md	1.72	1.93	93.49	0.73	2.13	100.00
15	Stone Lime from Engles, W. Va*	Rockville and Germantown, Md.	12.71	2.20	67.16	16.83	2.13	101.03
16	Stone Lime from Buckeystown, Md	College Park, Md	1.69	0.74	77.16	1.19	19.22	100.00

*Composite samples.

NOTE:—The gaslime contained, in addition to the above, small amounts of sulphur, sulphuric acid, and phosphoric acid; and the oyster-shell lime small amounts of phosphoric acid. These have been added in to make the total.

MARYLAND MARLS.

Marls are found in large quantities in many parts of Maryland; and have been used more or less for agricultural purposes for many years. From the small quantity of plant food which marls furnish, and the difficulty and expense of handling and transportation, their use is generally confined to places very near the deposits.

Marls may be considered in three classes, according to their general character and the geological formations in which they occur, being only three of the many formations in this State. These formations are found, as a rule, one above the other, but it is rare that more than one occurs in a single exposure. The upper marl known as shell marl or blue marl, is found in the Neocene or the most recent of these formations, at very near the surface. It consists chiefly of seamud, with sand and clay and partially decayed shells and bones. Its value depends mainly on lime, which it contains in the form of the carbonate. This class of marls usually has a very small per cent. of phosphoric acid and potash, although sometimes it contains beds of glauconite which gives a higher potash value. The physical character of these calcareous marls varies with the class of animal remains from which they are derived, and the state of preservation of the same. To this class belong most of the marls that have been examined at this Station, as this Neocene formation covers a large area in Southern Maryland.

The second class of marls is found in the Eocene formation, which is older than the Neocene and is just below it in the geological order. It is friable and somewhat chalky, consisting of comminuted shells and corals, and is of a light color. The agricultural value of this variety is given by the potash and the carbonate of lime which it furnishes. The glauconite or green sand may be expected to be found in this class. In parts of New Jersey this is very prominent, but the per centage of potash has been found, as a rule, to be much lower in this State.

The third class, or that which has the lowest geological position is the cretaceous marl. This also contains glauconite and is commonly known in New Jersey as "green sand." There are very few exposures of this formation in Maryland and it is difficult to distinguish it from the Eocene. Marls of this class vary considerably in their chemical composition and agricultural value. They owe their fertilizing quality to the presence of phosphoric acid and potash, and sometimes contain a goodly admixture of calcareous matter. The best New Jersey marls, and those that have been used with the most success, have contained from two to three per cent. of phosphoric acid and from five to seven per cent. of potash. The few Maryland marls of this class that have been examined thus far have not given nearly as high a per cent. of these ingredients.

Marls occur in each of these three geological formations in a succession of beds varying in thickness from a few inches to many feet, and separated by layers of gravel, sand or clay. There may be many of these beds of marl in the same formation, and several beds of the same class are often seen in the same exposure, but the different classes of marl are rarely seen together.

The potash of marls, being in an insoluble form, must necessarily act very slowly in the soil. Much of the potash in marls will become slowly available to plants through weathering, but a considerable amount of it could be rendered available by the action of lime, which probably takes place through the formation of the double silicates spoken of on page 95. This change could readily be brought about by burning those marls which contain considerable Calcium (lime) Carbonate, and then slacking the product. This could be performed with profit with some of the marl deposits of the State and give a cheap source of lime, at the same time furnishing some potash and phosphoric acid. Such applications would be highly beneficial to the lands on the farms in the neighborhood of such deposits.

The following table gives the results of the examination of ninety-five separate samples from various parts of this State. Collectively, the samples reported upon in this table XXV are believed to represent in character and composition, all the deposits in Maryland, which are so exposed as to be accessible for use.

TABLE XXV.

Description and Composition of Marls sent to the Experiment Station for Analysis.

H. J. PATTERSON, Analyst.

(Figures indicate per cents, or pounds in 100 pounds.)

Laboratory No.	Description and source of sample.		Insoluble matter.	Lime (CaO)	Phosphoric acid P_2O_5	Potash K_2O
35	Upper layer 7 feet thick.	Sent by H. M. Murray, West River	68.50	0.38	0.58	3.22
36	Under No. 35, 5 feet thick.	" " " " "	63.77	0.25	0.32	3.02
37	Under No. 36, 40 feet thick.	" " " " "	68.45	0.25	0.34	3.52
38	Deposit near Stream.	" Richard Baldwin, Waterbury	89.02	....	0.08	0.25
42	Sand and shell marl.	" Spear and Critcher, Glymont	46.12	31.92	0.14	0.49
43	" " "	" " " "	62.71	17.22	0.05	0.59
49	Lime marl.	" Fred. Sasscer, Upper Marlboro	70.76	0.23	0.58	2.37
50	Shell marl.	" " " " "	60.51	14.71	0.12	1.89
54	Sand marl.	" L. B. Johnson, Piscataway	61.84	5.37	0.16	1.57
55	" "	" " " "	44.71	9.00	0.24	2.08
83	Chalky marl.	" Dr. Chas. Lowndes, Easton	18.77	39.90	0.32	0.18
92	Sand and shell marl.	" Geo. Taylor, Glymont	67.70	1.88	0.80	1.78
447	Light brown shell marl.	" J. A. Cunningham, Friendship	77.82	8.56	0.44	0.84
448	" " marl.	" P. H. Prout, Friendship	82.67	8.00	0.26	0.28
449	Sand marl.	" J. A. Wood, "	92.23	1.06	0.88	0.59
450	" "	" " " "	92.19	1.00	0.52	0.23
451	Shell marl.	" " " "	76.62	11.19	0.89	0.22
452	" "	" " " "	80.28	9.50	0.14	0.42
453	" " rock.	" " " "	98.02	....	....	....
454		" L. M. K. Griffith, Dunkirk	83.37	4.25	1.74	0.44
455	Shell marl.	" " " "	84.96	0.56	0.12	0.52
456		" " " "	81.86	trace	0.12	2.49
457		" " " "	80.04	"	0.30	2.40
459	Shell marl rock.	" " " "	96.96	....	....	....
461	" "	" E. L. F. Hardcastle, Lee Haven	38.89	28.37	2.22	0.43
462	" "	" " " " "	26.21	31.94	0.30	0.32

536	Light gray, partly decomposed.	“	T. F. Lansdale, Triadelphia	.....	trace	trace	0.25
537	“ “ sandy appearance.	“	“ “ “	.....	“	“	0 26
585	Shell marl.	“	T. R. Brooks, Seat Pleasant	65.48	12.37	0.24	1.41
586	Blue or green sand marl.	“	“ “ “ “	76.11	4.38	0.30	1.84
587	Shell marl.	“	“ “ “ “	69.37	9.88	0.16	1.62
588	Shell marl.	“	“ “ “ “	51.41	22.20	0.16	2 85
589	Shell marl.	“	“ “ “ “	64.54	12.37	0.12	1 39
590	Brown sand marl.	“	“ “ “ “	81.22	1.50	0.20	2 08
591	Blue or green sand marl.	“	“ “ “ “	81 84	1.00	0.20	1.71
592	Shell marl.	“	“ “ “ “	53.34	16.87	0.16	2 29
593	Marl rock.	“	R. S. Mitchell, Glymont	36.09	29.00	0.12	0.23
594	White chalky marl.	“	Dr. Chas. Lowndes, Easton	13.21	45.88	0.16	0.24
605	Marsh mud.	“	Thos. Hill, Baltimore	87.57	1.38	0.12	0 23
606	“ “	“	“ “ “	87.34	1 25	0.14	0 22
610	Light gray marl.	“	Dr. Chas. Tilghman, Tunis Mills	57.58	20.90	0.40	0.29
611	Dark gray marl.	“	“ “ “ “ “	74.00	13.12	0.28	0 38
612	Muck.	“	“ “ “ “ “	20.88	trace	0.28	0.69
		NEOCENE MARLS.					
1026	Shell marl.	From	Jones' Wharf	46.76	24.55	0 10	0.24
1025	Under No. 1022.	“	Cove Point	67.24	15.30	0.06	1.88
1027	Shell marl.	“	Plum Point	71 43	13.70	0.38	0.72
1021	“ “	“	“ “	73 08	13.45	0.38	0 31
1022	Yellowish-green marl.	“	Cove Point	73.07	12.15	0 06	0 33
		EOCENE MARLS.					
1107	Shell marl.	From	Bel Alton	65.51	1.25	2.26	4.76
1106	Shell marl, under No. 1107.	“	“ “	67 68	5.10	0 29	4.17
1108		“	“ “	80.94	0.85	0.45	0 73
1167	Green sand marl.	“	Upper Marlboro	75 33	0.45	2 45	2 88
1030	“ “ “	“	Donaldsonville	80.11	10.30	trace	2.71
1019	Shell marl, under No. 1029.	“	Clifton Beach	52 93	12.70	0.20	2 36
1028	Green sand and shell marl.	“	Pope's Creek	78.25	trace	trace	2.35
1105	Shell marl.	“	Bel Alton	66.00	5 90	0 24	2.34
1079	Green sand marl.	“	Mathias Point, Va.	78.66	trace	trace	1.81
1023	Shell marl.	“	Clifton Beach	59.85	11.45	0.16	1.11
1024	Green sand and shell marl.	“	Potomac Creek, Va.	84.52	0.85	0.08	1.04
1147	“ “ “	“	Seat Pleasant	50.59	9.10	0 16	0 64
879	Green sand marl.	“	T. B.	83.46	1.25	0.19	0.59

TABLE XXV—*Continued.*

Laboratory No.	Description and source of sample.		Insoluble matter.	Lime (CaO)	Phosphoric acid P_2O_5	Potash K_2O
880	Green sand marl.	From T. B.	91.65	0.90	0.48	0.42
1029	Shell marl.	" Potomac Creek, Va.	59.09	17.30	trace	0.33
		CRETACEOUS.				
1146		From Seat Pleasant.	78.11	2.45	0.18	0.65
	UNCLASSIFIED MARLS AND MISCELLANEOUS.					
1166	Lime marl. 20 ft. below surface.	Sent by W. G. Worman, Frederick	8.80	50.10	0.08	0.28
799	Marl from near surface.	" George Earle, Millersville	75.39	12.19	0.48	0.21
798	" " " "	" " " "	87.90	1.62	trace	0.38
800	" " " "	" " " "	92.90	1.25	"	0.16
1148	Dirt from a well.	" W. O. Reeder, Laurel Grove	76.69	trace	0.29	1.32
878	River mud.	" A. T. Parsons. Salisbury	73.05		0.19	0.39
1169	Shell and sand marl.	" J. L. Rowland, St. Mary's county	82.81	7.37	0.16	0.43
1413	Lime and shell marl.	" Alonzo Berry, Williamsport	0.77	54.75	0.08	0.19
1451	Shell and sand marl.	" R. J. Manning, Accokeek	52.78	15.87	0.08	1.76
1455	Clam shell marl, partly decompos'd	" T. B. Dyer, Oxen Hill	64.28	11.25	0.04	1.81
1456	Sand marl.	" " "	89.21	trace	0.28	0.32
1457	Shell marl.	" " "	64.28	18.12	0.20	0.40
1458	"	" " "	34.21	33.87	0.24	0.34
1459	Sand marl.	" " "	77.74	0.05	0.36	0.80
1460	*Bone found in marl deposit.	" " "	2.46	.....	30.41	0.40
1541	Decomposed stone.	" W. S. Whiteford, Whiteford	89.92	trace	trace	trace
1726	Shell marl, M. A. E. S.		.....	..	trace	trace
1730	"	" J. B. Hallowell	22.83	27.25	trace	trace
1731	"	" "	29.30	35.25	trace	trace
1738	Shell and sand marl.	" Randolph Humphreys, Salisbury	63.58	2.15	trace	trace
1741		" F. G. Aukum, Washington, D. C.	59.75	7.25	1.40	trace
2075	Shell marl.	" Wm. B. Reed, Sr., Centreville	51.32	24.20	trace	trace
2076	Green sand marl.	" " "	70.90	1.20	.....	.....

2117	Shell marl.	"	Edward Lynch, Westminster	69 42	11.60	.....	.....
2129	" "	"	J. J. Collins Bishopville	68.92	13 64	.....	.....
2516	" "	"	H. Spear, Mason Springs	38.82	29.64	trace	0.37
25 0	" "	"	" "	80.91	9.20	trace	0 23
2572	" "	"	R. C. Booth, Piscataway	.....	16*00	0.32	0.12
2774	" "	"	P. W. Chew, Washington	57 21	21 46	0.62	0.10
2845	" "	"	J. W. Tnompson, Newport	.....	.....	trace	0*87

* The bones had the appearance of vertebra.

VALUE OF MARYLAND MARLS.

The value of Maryland marls usually depends upon the amount of shells which they contain. The green and bluish marls are not very valuable as they contain but little lime, and the potash which they contain is not very available to crops. Maryland shell marls have very little commercial value owing to the great proportion of worthless material they contain and their bulky nature, but *they have considerable agricultural value* and should be more extensively used than at present. In fact no farmer who has a deposit of shell marl, that is easily accessible, on his place can afford not to use it very generally and quite frequently on his land. Some time the shell marl may not act quite as quickly as caustic lime but in a series of years it will produce as good, and in some cases better results. The following results of experiments which have been conducted at this Station show beyond a doubt that applications of Maryland shell marl will produce very decided increases in the yields of crops.

TABLE XXIV.

Showing Effect of Shell Marl Compared with Other Sources of Lime.

(Yields in bushels and pounds per acre.)

Application.	Quantity, lbs.	4 Crops Corn.		3 Crops Wheat		4 Crops Hay, lbs.	Total 11 Crops.	
		Grain, bu.	Fodder, lbs.	Grain, bu.	Straw, lbs.		Grain, bu.	Forage, lbs.
Nothing	.....	97.5	10400	31.9	2697	5200	129.4	18297
Stone Lime	1400	127.7	11228	33.6	3607	6760	161.3	21595
Oyster Shell Lime	1400	129.9	11440	31.9	2967	8060	161.8	22467
Ground Oyster Shells	2600	148.4	12834	42.3	4095	7930	190.7	24859
Shell Marl*	13000	145.0	11858	43.4	4744	8580	188.4	25182

*The marl used in this experiment was from the same deposit as Sample No. 588, Table XXV.

In another experiment the application of two tons of shell marl per acre produced an increase of 16.7 bushels of corn and 450 lbs. of fodder per acre the first year.

In still another experiment the application of four tons of shell marl per acre did not produce any increase in the first crop of corn, but gave an increase of 3½ bushes of corn and 600 lbs. of fodder the second year and the third year increased the wheat yield 5½ bushels of grain and 1050 lbs. of straw. The marl used in these last two experiments was from the same deposit as sample No. 50, and while this is a fairly good marl yet it should have been applied much heavier than it was for best resuts.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 111. OCTOBER, 1906.

THE OYSTER SHELL SCALE.

Lepidosaphes ulmi Linn.

By T. B. Symons.

The Oyster Shell scale, one of the easily distinguished species of scale insects, is generally distributed over Maryland, and in fact is said to be found practically throughout the world. This scale has received treatment at the hands of writers on injurious insects for many years. Probably the first account of this pest in this country was written by Mr. Enoch Perley, of Bridgton, Me., and was published by the Massachusetts Agricultural Society in 1796. It is supposed to be an imported pest and to first have located in the New England States, but it has spread generally throughout the United States. Though it was never generally considered a very serious pest, yet early writers warned orchardists to be on the lookout for its introduction into their orchards. This insect has not been found to be very injurious to apple orchards in Maryland, with the exception of some few cases in Garrett County. In these orchards the pest has to be combatted with as much vigor as in controlling the San Jose Scale. Although it does more or less injury to various fruit trees, this bulletin is written with a view to calling the attention of the public to the insect's comparatively recent attack on maple trees. The injury being done by this pest to the sugar-maples in many parts of the State is very great, and no means have been employed for its control. Specimens of this scale on various trees have been received from time to time for a number of years; but it is only during the past two years that serious injury has been noted; and of its causing the death of many large maples.

The maple trees, as would be expected, and as shown in the accompanying cuts, are attacted usually in the upper and younger branches. This insect works and multiplies in each direction from the point of first infestation, killing the branches by sucking the juice of the trees, as it progresses. In cases where trees are killed there is no doubt but that they have been infested for some time. This fact illustrates the importance of not only giving fruit, forest, and shade trees, and ornamental shrubbery attention at the time of planting but also of frequently inspecting them.

To the general observer this may not appeal with the forcefulness that it does to the authorities of some of our small towns or to the individual property owner, where the insect has seriously injured or killed outright the great majority of the maple trees and often other shade trees. This condition has been observed in several small towns in this State, and it is only by a concerted effort on the part of their citizens that such a condition can be improved. It should be the duty of the citizens of every village or town to see to it that some officer gives the necessary attention towards the growth, development, and protection of their shade trees; for there is nothing that adds more to the comfort of the inhabitants and the beauty of the hamlet or city than its trees. In our large cities this important feature of municipal supervision is generally provided for. Accordingly the conditions which exist today in regard to the injury by the Oyster Shell Scale to our maple trees, by the San Jose Scale to the fruit trees as well as by other insects attacking various plants in many of our towns, would be prevented.

It may not be inappropriate in this connection, to refer to the war that is now being waged by the people of Massachusetts and New Hampshire against the Gypsy and Brown-tail moths, which pests threaten the annihilation of forest, shade, and fruit trees in parts of these states. While everything possible is being done by the authorities of those states and the United States Bureau of Entomology to prevent the spread of these insects to other states, it is possible at any time that either or both of them may be introduced into Maryland, therefore it is of prime importance that not only should the people at large pay some attention to their shade trees in order to prevent any injury being done by an insect but also towns and municipalities should take vigorous action in the control of any injurious insect pest.

LIFE HISTORY.

The different stages of the insect's life history are shown in the accompanying cuts, figures 1 and 2. Figure 1 shows a female scale from below, revealing the tiny white eggs varying in number from 45 to 90, which are laid in early fall. Her dead body is also shown in the upper end of the scale. The insect passes the winter in the egg state. The eggs hatch early in May in this latitude into tiny young which crawl out upon the small twigs of the tree or bush and at once settle, inserting their beaks into the bark of the food plant. While the young twigs are usually infested yet the scale is often found on the larger twigs and branches and even on the trunks of trees. In the north this insect is supposed to have only one annual generation. In this State, Prof. Johnson reports in Bulletin No. 20. U. S. Div. Ent. 1899, that there are two generations; the young of the second generation appearing the last week in July or the first week in August. Unfortunately we are not prepared to verify this statement at this writing from actual observation. It was intended to study the life history of this insect very closely this past year, but circumstances prevented. and we were only able to observe one single scale that we isolated on a lilac bush. In this case there was only one generation. The rapidity of the increase of the pest indicates, however, that there are probably two generations in this State.

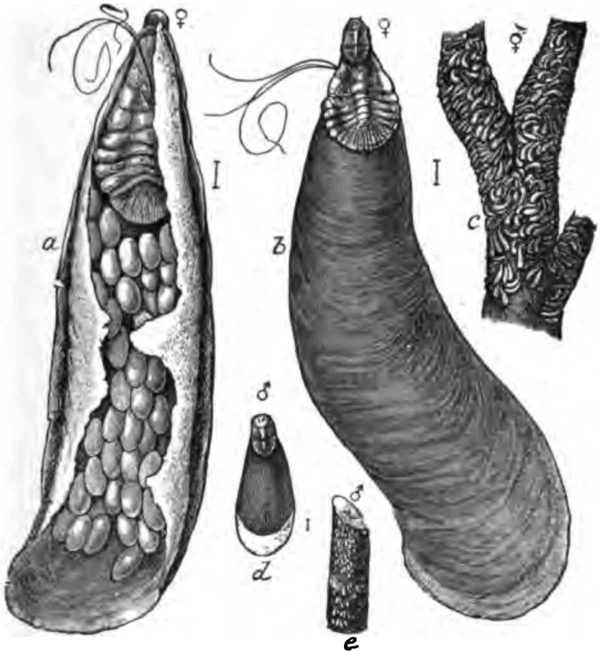

Figure 1—Oyster Shell Scale—(Lepidosaphes ulmi Linn.): a, female scale from below, showing eggs; b, same from above, greatly enlarged; c, female scales; d, male scale. enlarged; e, male scale on twig, natural size. After Howard, Yearbook, 1894. U. S. Department of Agriculture.

After inserting its beak the female molts twice, the molts aiding in the formation of the scale which is secreted mainly from the posterior end of the body. It continues to develop until reaching maturity when it lays the eggs previously referred to for either the second generation or for passing the winter. The male scale is much smaller than the female (see figure 1) there being a single cast skin; and the scale is hinged at its posterior part in such a way as to permit the escape of the winged adult (see figure 2). This winged male however, can do no injury, its only function being to assist in reproduction.

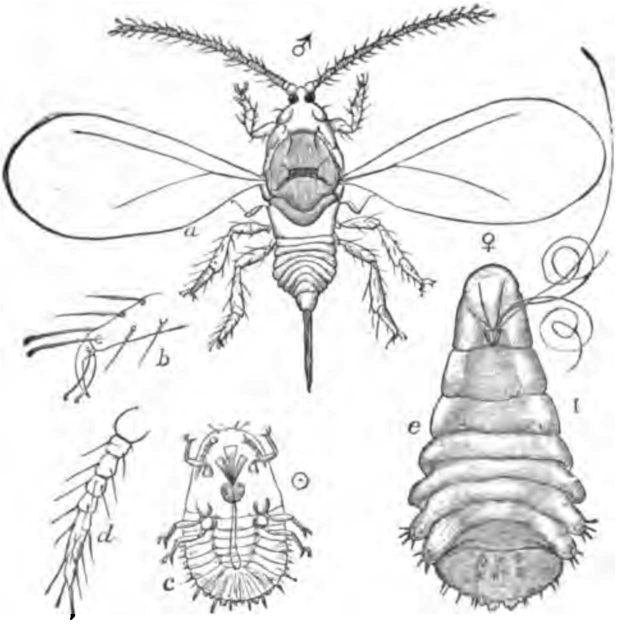

Figure 2—Oyster Shell Scale—(Lepidosaphes ulmi Linn.): a, adult male; b, foot of same; c, young larva; d, antenna of same; e, adult female taken from scale—a, c, e greatly enlarged; b, d still more enlarged. After Howard, Yearbook, 1894, U. S. Department of Agriculture.

FOOD PLANTS.

The Oyster Shell Scale apparently has a great range of food plants. In this State we have observed the insect attacking apple, plum, (see figure 3), pear, quince, silver maple, sugar maple, Norway maple, linden, willow, lilac, poplar. In the Yearbook of the U. S. Department of Agriculture, 1894, Dr. Howard, cited in addition to the above hawthorn, buckthorn, raspberry, currant, hop-tree, bladdernut, horse-chestnut, blackberry and cottonwood as found in the District of Columbia. Some doubt has been expressed as to the correct identification of the species in all cases, as the resemblance of some species is so very close that they will be considered the same upon superficial examination, and it is only a close study of the structural differences that reveals otherwise. The variety of its food plants has aided the

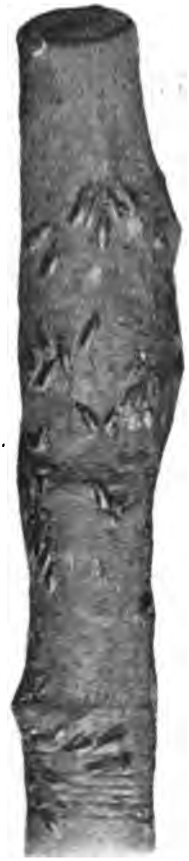

Figure 3—Oyster Shell Scale on maple.
Photo. by A. B. Gahan.

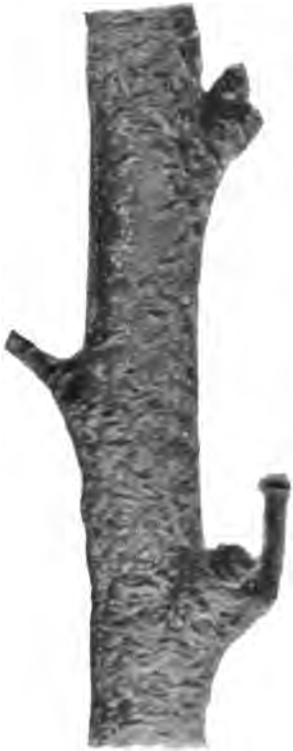

Figure 4—Oyster Shell Scale on plum.
Photo. by A. B. Gahan.

general distribution of this insect over the country. Its injury to various species of maple, lilac, and apple in this State point to the fact that it prefers these food plants in this locality.

EXPERIMENTS ON MEANS OF CONTROL.

As already stated this insect does its injury by sucking the juices of plants and accordingly must be controlled by a contact insecticide. As the insect winters in the egg state, recommendations have not commonly been made for destroying it at that season but it is usually advised treating just as the eggs hatch in early May. This method applies as a general rule, as it is seldom that an insect can be easily destroyed in the egg state. Kerosene emulsion applied just as the eggs hatch has been universally recommended for the control of the pest. This being the best solution to use when the plants are in foliage. However, since the general adoption of the lime, sulfur and salt wash for the control of the San Jose Scale it was suggested and recommended at times to treat plants infested with the Oyster Shell Scale during the dormant season, on the theory that the causticity of the lime, sulfur and salt wash would tend to slough off the scale and thereby expose the eggs to the action of the weather, which would either wash or blow them off. The lime, sulfur and salt wash, when properly applied, remains on the trees well into the summer and will no doubt kill many of the young lice as they are hatched. Again, spraying at the dormant season permits of more thorough treatment and enables the work to be done at the same time that the orchards are being sprayed for San Jose Scale. So far as recorded no direct experiment with the lime, sulfur and salt wash on Oyster Shell Scale on maple trees have been reported. Therefore, owing to the great amount of damage being done by this insect in this State it was decided to test the effect of the lime, sulfur and salt wash applied to maple trees in both the fall and spring and compare it with the kerosene emulsion treatment given in May. The experiments conducted were rather limited in number but the results in each case were quite conclusive.

Credit is due Mr. A. B. Gahan and Mr. W. C. Travers for work in the application of the washes and to Mr. Gahan for taking notes on the same. We also wish to thank the gentlemen on whose places the work was conducted for their cooperation.

Experiment No. 1—November 15th, 1906, eight large maple trees, the smallest eight inches in diameter, at the country home of Mr. Arthur Boehm, near Towson, were sprayed with the lime, sulfur and salt wash 20-15-10 respectively. The trees were badly infested with Oyster Shell Scale, the tops of some of them being killed. Some trees at Mr. Boehm's as well as several on an adjoining property were left as checks. Examination of these trees in early spring and late in August showed that the treatment gave good results, as very few scales could be found on the treated trees, while the untreated ones showed con-

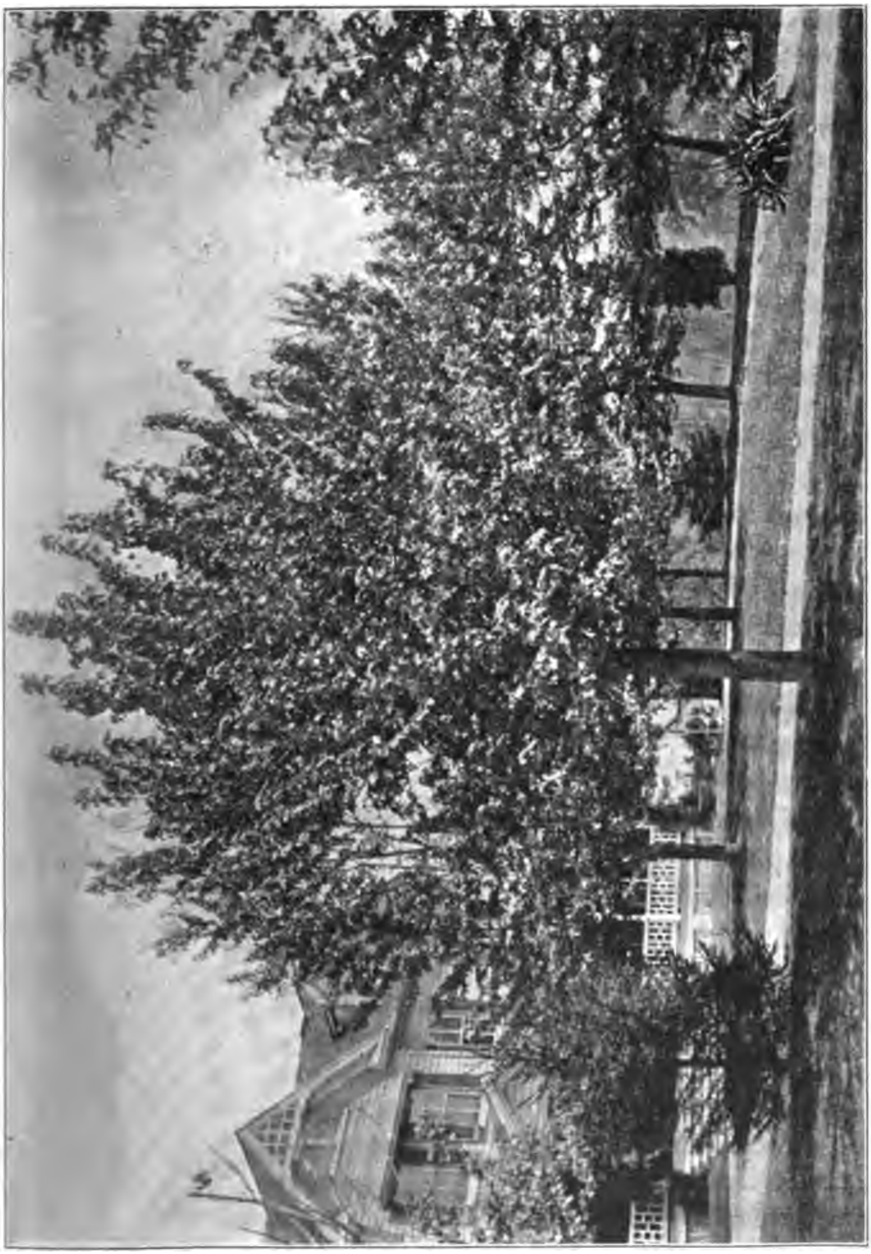

Figure 5—Showing growth of tree in foreground that was severely cut back and sprayed in the fall. Photo. by A. B. Gahan.

siderable increase of the pest. Figure 5 shows the appearance of the trees this summer. Note the manner in which the tree in the foreground has grown after being severely cut back and sprayed in the fall.

Experiment No. 2—To test the effect of the lime, sulfur and salt wash applied in the spring, three large maple trees in the yard of Mr. Zouck at Reisterstown, were treated April 27th, 1906.

Examination of these trees during the summer and fall showed that while the wash gave satisfactory results, the trees were not as clean of the scale as those treated in the fall. This was no doubt due to the fact that the spraying was not quite as thorough on account of weather conditions at the time of the application. There was, however, a striking difference between the treated and untreated trees at this place.

Experiment No. 3—Five badly infested maple trees were sprayed with kerosene emulsion, made with Tak-a-Nap soap, May 7th, 1906, at Mr. Chesney's, Sherwood, Md. The young were crawling quite plentifully at the time of the application.

Examination of the treated trees, June 4th, 1906, showed practically all of the crawling young to have disappeared with only a few having settled on the terminal twigs of one of the sprayed trees, while the checks showed the brood to have settled and developed. Later examination, September 14th, showed the treated trees to be in excellent condition while the untreated ones were badly infested.

DEDUCTIONS FROM THE EXPERIMENTS.

1. That maple trees infested with the Oyster Shell Scale can be treated in both fall or early spring with the lime, sulfur and salt wash with satisfactory results, as regards controlling the pest and without injury to the trees.

2. That where one application is made these tests showed the fall treatment to be preferable. It is the belief of the writer, however, that when the wash is applied thoroughly in early spring equally good or even better results can be obtained.

3. That it is advisable to employ the lime, sulfur and salt wash for the control of the pest, only when it is desired to treat the trees during the dormant season, when they can be sprayed more thoroughly than when in leaf. In cases where this wash is employed for the control of the San Jose Scale, all the spraying of this character can be done at one time.

4. That Kerosene emulsion applied just as the young scale insects are crawling, early in May, is very effective in controlling the insect. Exceptional results were obtained in this experiment. It may be stated that the Tak-a-Nap soap used in making the emulsion is very satisfactory as it dissolves easily in cold water.

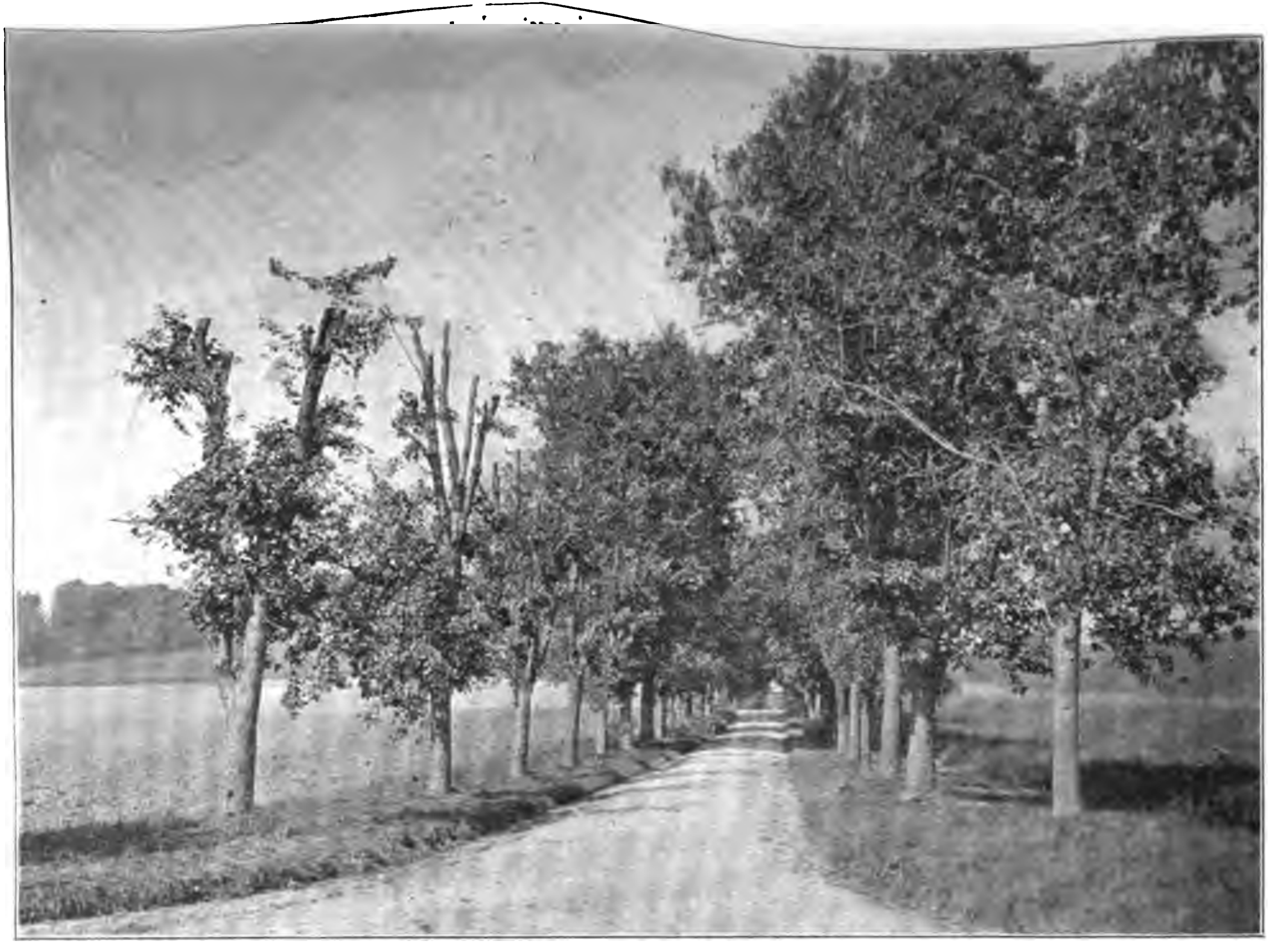

Figure 7—Injured trees cut back, ready for treatment, near Lutherville.
Photo. by A. B. Gahan.

RECOMMENDATIONS.

Inasmuch as this pest has so many food plants the home keeper should be on the lookout for its introduction to his place before it does any serious damage. Where maple trees are infested, the dead parts of the trees should be cut out and the trees sprayed either with lime, sulfur and salt wash while the trees are dormant, or with fifteen per cent. kerosene emulsion, when the eggs hatch in early May and if a second brood of young appears about the last of July or first of August, another application should be made. The insect is not a hard one to combat and it is only in cases of neglect that it reproduces sufficiently to kill the plant that it attacks.

The problem of spraying large maple trees is somewhat difficult, and while they may be treated with a hand pump, the operator climbing the trees in order to reach all parts, it will generally be found advisable to employ a good barrel pump for the work. In treating very large trees it will be necessary to have a high platform and to use long extension rods in order to spray the tops of the trees properly.

KEROSENE EMULSION.

Any desired per cent. of kerosene emulsion in a wash may be accurately secured. The fifteen per cent. emulsion, which should be used in treating trees and plants infested with the Oyster Shell Scale in early May in quantities of fifty gallons should be made as follows:

Water	5 gallons.
Ordinary hard soap*	1½ pounds.
Kerosene (150 degrees)	7½ gallons.

Pour the 7½ gallons of kerosene in the spray pump barrel, slice the soap and dissolve it in the water, which should be heated to the boiling point. Pour the hot water with soap dissolved into the spray barrel and thoroughly emulsify by pumping the mixture back into itself for ten minutes, moving the nozzles around all the while. The emulsion when properly made, should be of a creamy white consistency, and may be diluted with any desired quantity of water, without the oil separating to the top. If 37½ gallons of cold water, making fifty in all are added, there will be a fifteen per cent. kerosene emulson.

NOTE—In our experiments Tak-a-Nap soap, sold by the Thayer Hovey Co., Darby, Pa., was used. In using this soap in making the emulsion it is not necessary to have the five gallons mentioned in formula heated but simply mix the soap with the cold water and then emulsify with the given amount of kerosene. Using this soap saves some trouble in not requiring eated water.

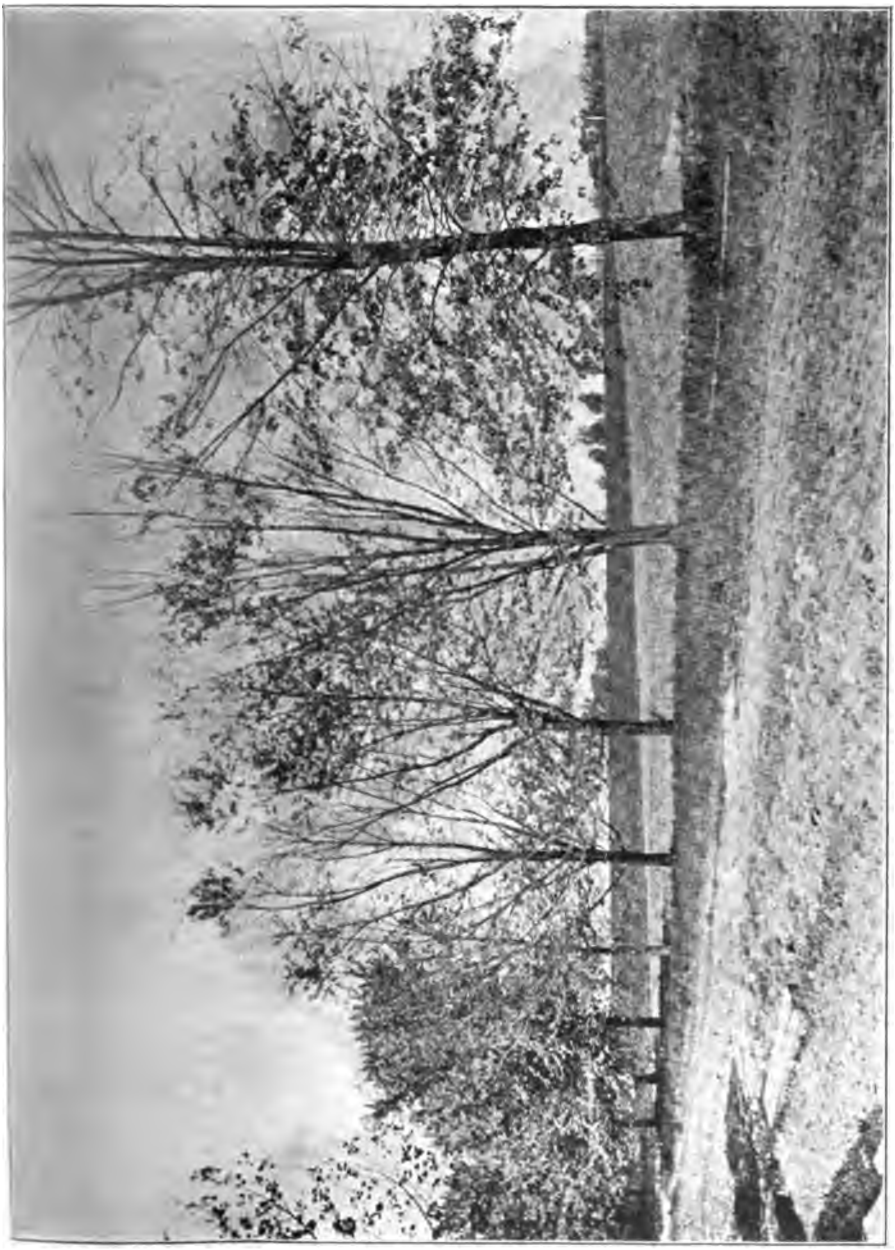

Figure 6—Part of a row of maples, seriously injured by the Oyster Shell Scale, near Towson. Photo. by A. B. Gahan.

LIME, SULFUR AND SALT WASH.

The standard formula for making this wash as employed for the control of the San Jose Scale applied during the dormant season can be used in treating for the Oyster Shell Scale, and is as follows:

Good quality freshly burnt stone lime	20 pounds.
Flowers of sulfur or flour of sulfur	15 pounds.
Common salt	10 pounds.
Water	50 Gallons.

Put 20 gallons of water in an iron pot or hog scalder and bring it to a boil, and then add stone lime and sulfur. The sulfur should have been made into a paste with hot water before placing it in the boiler, in order to facilitate its mixing. After the lime and sulfur have been boiled for sometime add the salt. Boil the mixture, stirring occasionally, from 30 minutes to one hour, or until the sulfur is thoroughly dissolved and produces a clear amber colored solution. Then dilute by adding sufficient hot or cold water to make 50 gallons. Pass the mixture through a strainer with at least 20 meshes to the inch, into the spray barrel and apply to the trees warm.

Figure 8 shows a very convenient boiler for making the wash, in addition this form of boiler is very handy on a farm for other purposes, and it is relatively inexpensive. A fuller description of this kind of boiler including plan and measurements, and of the lime, sulfur and salt wash will be given in a forth-coming bulletin of this Experiment Station.

For applying this solution select a good spray pump that has all its working parts brass and furnishes a constant high pressure. Use any of the nozzles that are suitable for applying kerosene emulsion or Bordeaux mixture.

The spraying is somewhat disagreeable and the solution is slightly corrosive, so that the man doing the work should be provided with rubber or oilskin coat, hat and gloves and a pair of goggles. It is a good plan to rub vaseline on the hands and face to prevent the spray solution from irritating the flesh. The horses attached to the spray wagon should be covered with blankets or old sacks. The aim should be to spray thoroughly and see that every part of the tree is covered. In order that this may be done with facility the hose should be long enough to enable the man to reach all sides of the tree without moving the barrel. Trees which have been thoroughly sprayed present a whitened appearance when dry. After drying it is easy to detect the parts that have been missed, and these should be gone over.

There are a great many kinds of spray pumps on the market and each person must select that which suits his taste and needs.

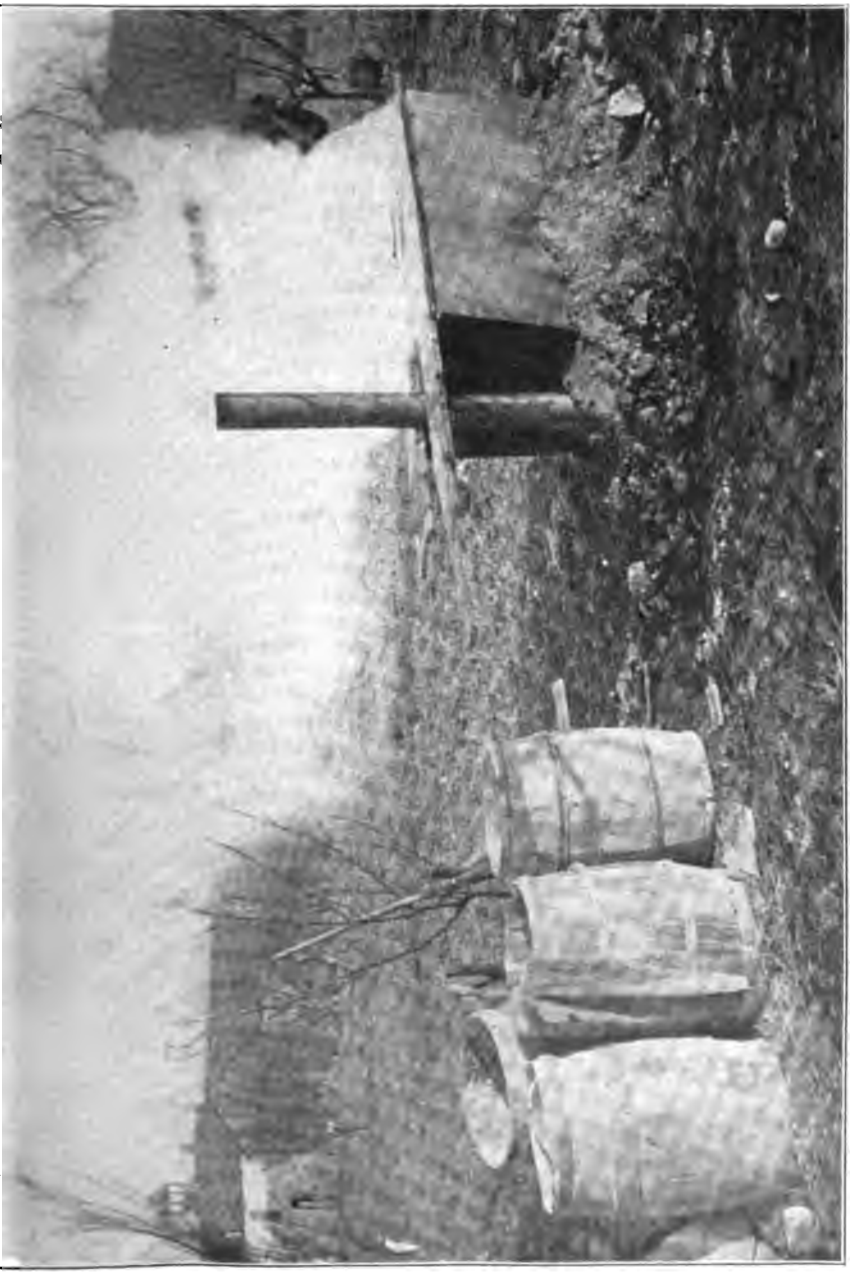

Figure 8—A cheap and convenient way of making the lime, sulfur and salt work.
Photo. by A. B. Gahan.

The following are manufacturers and dealers in pumps and supplies:

F. W. Bolgiano & Co., 935 B St., Washington, D. C.
Field Force Pump Co., Elmira, N. Y.
Gould Mfg. Co., Seneca Falls, N. Y.
Griffith & Turner, Baltimore, Md.
Morrill & Morley, Benton Harbor, Mich.
Myer Pump Co., Ashland, Ohio.
L. G. Orndorff, 203 7th St., N. W., Washington, D. C.
Spray Motor Co., Buffalo, N. Y.
Geo. H. Stahl, Quincy, Ill.
The Deming Co., Salem, Ohio.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 112. NOVEMBER, 1906.

TREATING SAN JOSE SCALE.

RESULTS OF EXPERIMENTS CONDUCTED IN 1906.

By T. B. Symons and A. B. Gahan.

The constant demand for up-to-date information in combatting the San Jose scale makes necessary this publication, based upon the results of experiments conducted by this Department during the past year, upon co-operative experiments with the Bureau of Entomology, United States Department of Agriculture, and also upon general observations in this and in other States.

It is generally conceded that the business of fruit growing can be conducted at this time with as much, and even more, success than previous to the advent of the San Jose scale in the State. The pest has required orchardists to give the trees closer attention, and in doing this, they have observed other needs that they had hitherto neglected. Better general culture and fertilization, together with a greater interest in the control of other injurious insects and plant diseases have resulted. In addition, the insecticide generally employed for the control of the pest, viz., lime, sulphur and salt, is decidedly beneficial to the health of the trees. The result has been a tendency to produce a better quality and larger quantity of fruit which demands a more remunerative price.

Again, the San Jose scale is a source of advantage to the up-to-date orchardists, in that it is forcing out of competition the ones who do not give their trees proper attention, and who market a class of fruit which tends to bring the price below a profitable basis. In order to reap the benefits of this advantage, however, it is necessary that the grower exercise constant vigilance in the care of his orchard.

The phase of the control of the San Jose scale to be considered at this time is, therefore, what is the best wash that the progressive orchardist can apply to his trees, keeping in mind effectiveness, general health of the trees, cost, and difficulty of application? It is, indeed, a strange characteristic of the general public, and especially of those engaged in the various branches of agriculture, that, after procuring satisfactory results from a certain remedy, article of machinery, seed or plant, they are prone to employ something *new*, which has not been given a practical test under the many varying conditions which always exist. Far be it from our wish to convey the thought of discouraging experimentation in any phase of activity, but let those who wish to employ new insecticides employ them as an experiment on a comparatively small area, and not leave the fate of their whole orchard in the hands of a "quack salesman." One should only employ such untried insecticides in treatment of cases where no effective remedy is known. In the case of the San Jose scale, we have an effective means of control, and this should be employed until entirely satisfied by practical demonstration that a new preparation has distinct advantages over the old.

GENERAL CONDITIONS IN THE STATE.

It can be stated with all assurance that the progressive orchardists of this State have no difficulty in controlling the San Jose scale. There are, however, any number of comparatively small orchards in the State owned by men not especially interested in fruit growing that are serving as distributing points for the pest to a greater or less extent. It is the duty of the State Entomologist to seek out and abate such nuisances, by the enforcement of the State Horticultural Law. This duty is being performed in cases which come to our notice, and the inspection of orchards is being carried on in so far as our limited appropriation will permit. While there is a marked advance in the treatment of infested orchards in the State, yet there is much room for improvement. The inspection and enforcement of the law is not carried nearly so far as the officers of the State Horticultural Department would desire, yet all that is possible under our present means is being done.

HEDGES.

One serious factor contributing to local infestation in many parts of the State is the Osage orange hedges. It is very evident in certain districts, where hedges are generally employed as fences, that they aid materially in the dissemination of the pest, as hedges are the favorite gathering places of many birds and the birds are the principal means of distribution of the scale. It is only rarely that one finds one of these hedges that is not a harbor for the San Jose scale; practically every one examined in the State has been found infested. One unfortunate feature is that the hedge is so hardy, that the pest, though killing many parts and causing it to present a ragged appearance, seldom kills it outright; therefore, it stands as a continual menace in distributing the pest in any vicinity.

In the writers' opinion the Osage orange hedge is an undesirable fence, under any conditions, but especially so when it becomes a menace by harboring pests. The accompanying picture (Fig. 1)

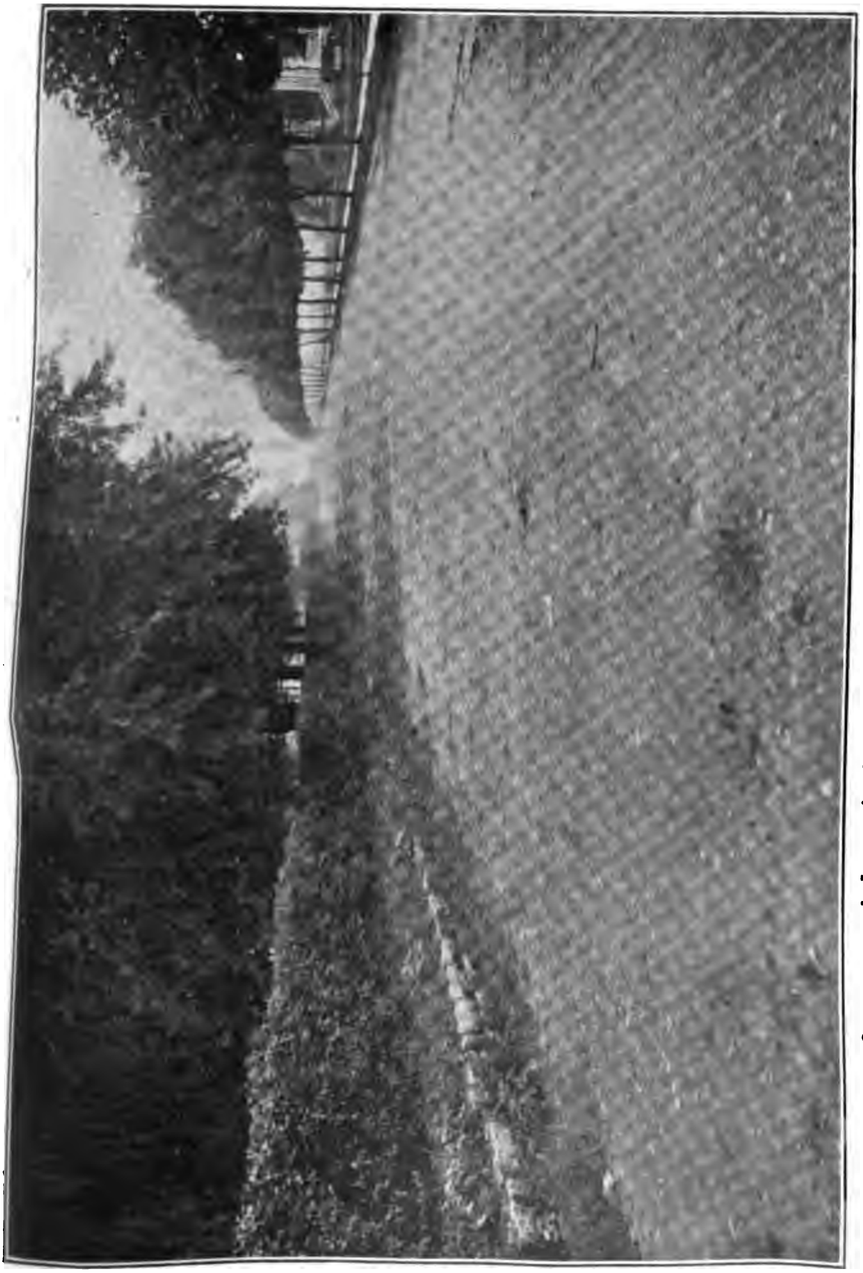

Figure 1.—An Osage orange hedge, seriously infested with San Jose scale, within the limits of Frederick City. Photo. by T. B. Symons.

shows a hedge which apparently presents a good appearance, yet is badly infested with the scale. It will be necessary for orchardists and general farmers to spray the hedges on their farms with the same regularity displayed in treating the orchard. It will also be necessary for the law to be enforced in treatment or destruction of hedges, as well as with neglected orchards. It may be stated here that the hedge should be treated while dormant, with the lime-sulphur or other effective insecticides.

EXPERIMENTS.

The experimental work herein detailed is to some extent a continuation of that recorded in Bulletin 107 of this Station. Several new principles are involved, however, viz.: (1) A comparison of single treatments in fall and spring and a double treatment, one application being made in the fall and one in the spring; (2) the relative value of flowers and flour of sulphur: (3) the ascertainment of whether the lime-sulphur treatments can be relied upon for apple trees or not, it having been asserted that apple trees cannot be effectively treated with these mixtures. In order that our experiments might demonstrate the truth or falsity of this proposition, we secured mostly apple orchards for our work the past year. All told, about 840 apple trees and 540 peach trees were used, making a total of 1,380 trees in the experiments. As formerly, we secured, as far as possible, orchards that were badly infested, but that had not yet been badly damaged.

The orchards were located as follows: 200 apple trees belonging to Gardiner Bros., at Jessup; 140 apple trees belonging to Mr. Robert Owens and 50 peach trees belonging to Mr. R. O. Shipley at Harmans; 250 apple belonging to Mr. J. B. Ennis; 100 apple belonging to Mr. Miller, and 100 peach belonging to Mr. Millard at Laurel; 360 peach and 100 apple belonging to Mr. E. E. Martz, Boonsboro, and 50 apple belonging to Mr. E. Wade, Passadena.

The orchard of Mr. Ennis was the same one treated in 1905, in co-operation with the Bureau of Entomology, United States Department of Agriculture, and which had become quite badly reinfested from the check plots (one on each side of the orchard), and from three or four plots that in the 1905 experiments were treated with weak or poor mixtures that did not kill the scale. The co-operation of the United States Department was continued in the treatment of this orchard in 1906 and was extended also to the orchards of Mr. Owens and Mr. Shipley, at Harmans.

DETAILS OF EXPERIMENTS.

The experiments comprise tests of the following combinations of lime and sulphur; lime, sulphur and salt, and lime, sulphur and caustic soda.

(1) 30 lbs. stone lime, 25 lbs. sulphur (flowers), 50 gal. water boiled 1 hour.
(2) 25 “ “ “ 20 “ “ “ 50 “ “ “ 1 “
(3) 20 “ “ “ 15 “ “ “ 50 “ “ “ 1 “
(4) 20 “ “ “ 15 “ “ “ 50 “ “ “ 2 “
(5) 20 “ “ “ 15 “ “ “ 50 “ “ “ ½ “
(6) 30 “ air slaked lime, 15 lbs. “ “ 50 “ “ “ 1 “
(7) 40 “ stone lime, 15 lbs. “ “ 50 “ “ self boiled
(8) 20 “ “ “ 15 “ “ 10 lbs. salt, 50 “ “ boiled 1 hour.
(9) 30 “ “ “ 15 “ “ 6 lbs. caustic soda, 50 gals. water.
(10) 20 “ “ “ 15 “ “ 10 “ “ “ 50 “ self boiled
(11) 15 “ sulphur, 10 lbs. caustic soda, 50 gals. water.

Numbers 2, 3, 4 and 5 were duplicated, using the flour of sulphur, several plots being treated with these washes. As in 1905, several patent insecticides were included in the experiments, viz.: Scalecide, Kil-o-scale and Target Brand Scale Emulsion.

The co-operative work at Laurel with the Bureau of Entomology of the Department of Agriculture consisted of the application in the fall only of washes made according to formulas 1, 2 and 3. Eighty-six trees were treated in the fall only, 70 receiving both fall and spring treatments, and 65 spring treatments only. The trees of each lot were divided as equally among the three different washes as practicable. The co-operative work at Harmans and Jessup consisted of the application of all of the eleven above-mentioned formulas to both peach and apple and also included plots of apple sprayed with the three patent insecticides mentioned.

RESULTS OF DIFFERENT TREATMENTS.

Lime-Sulphur Mixtures.

These washes were almost uniformly successful—so nearly so, in fact, as to make it exceedingly difficult, if not impossible, to draw conclusions, as to the comparative values of the different formulas. As formerly, the mixtures to which external heat was applied in the preparation were more successful than those prepared by means of the heat generated by the materials themselves. The plot of 10 trees at Jessup, sprayed with formula 7, in which the lime alone was depended upon to furnish heat, gave quite unsatisfactory results. Notwithstanding 40 pounds of a good quality of stone lime were employed, not enough heat was generated to dissolve the sulphur, and, as a consequence, most of it remained in the free state, giving a very weak wash.

Formula 6, in which air-slacked lime was used, also gave very poor results on apple in our own experiments; but it may be said that in one case coming under our observation a peach orchard was treated by a private party with the same mixture and quite satisfactory results obtained. These conflicting results seem to indicate that air-slacked lime is not as dependable as the stone lime, but that it may be used as a makeshift substitute for the latter.

In all our former publications in regard to the lime-sulphur washes the use of the flowers of sulphur has been recommended. The question having arisen as to whether the cheaper grade of sulphur, known as flour, would not serve as well, several experiments designed to determine the compartive effectiveness of washes made from the two grades were undertaken. As stated above some solutions were made up, substituting flour of sulphur for the flowers of sulphur in formulas 2, 3, 4 and 5 and trees sprayed with each. Over 150 trees, including both peach and apple, were treated with these washes, the trees being about equally divided between the four preparations. A comparison of these plots in September failed to establish any advantage in favor of the more expensive grade of sulphur.

These results, combined with former observations on this point, and as the flour is somewhat cheaper than the flowers, besides less given to lumping and, therefore, easier to mix into a smooth paste, lead us to say that either grade of sulphur mentioned may be used in making the lime-sulphur wash.

Very little difference was manifested between the mixtures cooked a half-hour and those receiving a longer cooking—what little advantage there was being in favor of the longer cooking. The results from the mixtures cooked a half-hour were quite satisfactory, only one or two live scale being found on any plot in September. Most of the mixtures receiving an hour or more of cooking gave perfect results, i. e., no live scale could be found when the summer breeding period was over. This is the more remarkable when we consider that most of the trees upon which these washes were used were apple, which are supposedly harder to successfully treat than peach.

Regarding the attempt to determine the comparative effectiveness of fall only, fall and spring both, and spring only treatments, it can only be said that all of these treatments proved so thoroughly effective as to leave no basis for comparison. Examinations in September of Mr. J. B. Ennis's orchard, in which these experiments were carried out, showed the treatments in every case to have resulted practically in extermination.

In this connection mention should be made of the fact that the fall applications were made quite early (October 30), and the spring applications quite late (April 3) in the dormant season. Thus the fall application found the scale not yet completely dormant and for that reason more susceptible to treatment, while the washes put on so late in the spring were still adhering to the trees when the scale again became active.

There can be no doubt that the time of application had a great deal to do with the success of these treatments. Previous to this year the late application has proven superior in all experiments conducted by this department, no doubt because it remains on the trees well into the breeding season and prevents the young of the few females that manage to escape the spray from finding a place to settle

It is still our opinion that a late spring treatment is preferable, but where the orchardist finds it impossible to put off the spraying until that time, owing to other duties, he will very likely find it advantageous to do the work as early in the fall as possible, without injuring the trees. This should be about October 30.

Considering what has been said regarding the success attending the use of the lime-sulphur washes the past season and bearing in mind that a majority of the trees sprayed were apple, it will quite naturally be inferred that the wash is an entirely efficacious treatment for apple as well as peach. However, a doubt is cast upon the correctness of this conclusion by the variableness in results of similar experiments upon apple in former seasons as well as by the indifferent success of some orchardists who have used it, and the experience of other experimenters along the same line. The rough bark and hairy terminal shoots of the apple afford the scale a hiding place in which it is protected from the wash and thus a few will manage to escape a thorough application. Nevertheless, while the results of lime-sulphur seem not to be so uniformily successful upon apple as upon peach, it has proven quite satisfactory in most cases, much more so than any of the other washes tried.

Several attempts have been made to ascertain whether increasing the amounts of lime and sulphur would not render it more effective. If an opinion were to be based entirely upon the past season's work, it would be that the ordinary strength used for peach will prove satisfactory in the treatment of apple, it having given good results upon the one as well as upon the other. Further, no difference could be noted between the efficiency of this strength and the stronger solutions. However, in the spring of 1905 about 250 apple trees were sprayed in co-operation with the United States Department of Agriculture, Bureau of Entomology, with mixtures ranging from normal (i. e., 20 pounds of lime and 15 pounds of sulphur to 50 gallons of water) up to 35 pounds of lime and 30 pounds of sulphur to 50 gallons of water, with the result that the stronger washes were apparently slightly more successful than the normal. Taking account of these results and also of the fact that spraying the past season for the San Jose scale has been more completely effective than usual (owing to climatic conditions, as will be later explained), it seems advisable to again recommend increasing the amounts of lime and sulphur in the normal formula, each five pounds, as a precautionary measure where badly infested apple trees are to be treated.

LIME-SULPHUR AND SALT.

Only two plots were sprayed with mixtures in which salt was an ingredient making about 70 peach and 30 apple. The results in both cases were perfect, but, as has been said, perfect results were also obtained from washes in which no salt was used, so that there appears to be no advantage in its use. This simply bears out our former recomendation in Bulletin 107.

LIME-SULPHUR AND CAUSTIC SODA.

Two plots, comprising about 10 apple trees each, were sprayed with solutions 9 and 10 respectively In both cases the lime and caustic soda were depended upon to furnish the heat. In No. 9 the lime was first slacked with the sulphur and the caustic soda afterward added, while in No. 10 the sulphur was first made into a paste and the caustic soda added to the paste, causing the sulphur to dissolve. The liquid was then used to slack the lime. The latter method gave much the better-looking solution, but no difference was discernible in the results obtained from the two solutions. Both were fairly satisfactory, only a few live scale being left in each case, showing, as in former experiments, that the self-boiled mixtures in which caustic soda and a good quality of stone lime are used can safely be substituted for the heat prepared mixtures, where apparatus for cooking by external heat is not available.

SULPHUR-CAUSTIC SODA.

A solution made according to formula No. 11 was sprayed upon about 10 trees at Jessup. The sulphur was mixed into a paste and dissolved by the addition of the caustic soda and then diluted. Like the foregoing self-boiled solutions, this one gave fairly good results, but as the number of trees was small and the past season an exceptional one, no great significance should attach to so limited a trial.

KEROSENE LIMOID.

The results of our 1905 experiments with this mixture, not having entirely accorded with the findings of some other experimenters we concluded to give it another trial. Accordingly, 30 peach and 10 apple trees at Boonsboro were treated with a 20 per cent. emulsion on April 11th. The peach were quite badly infested; the apple but slightly. When examined in September, these trees were all in very good condition, only a few live scale being found on the plot. Undoubtedly the lateness of the application, combined with the open winter, and fine weather following the spraying, account to some extent for this seeming reversal of our 1905 results. In view of the fact that the 1905 experiments with this wash were much more extensive than those of this year and of the further fact that the past season has been an exceptional one as regards the effectiveness of spraying for the San Jose scale, we are not yet convinced of its desirability as a substitute for lime-sulphur.

PATENT INSECTICIDES.

Kil-o-scale and Scalecide. Not having been thoroughly convinced by our former work with Scalecide and Kil-o-scale, that these preparations were wholly ineffectual, it was decided to try them again. Accordingly, plots at Jessup and Laurel were treated with each and also about 50 trees with Scalecide at Boonsboro. It was intended to treat a similar number of trees at the latter place with Kil-o-scale, but through some mistake of the express company the material failed to arrive in time for use. In these experiments two strengths of each preparation were used, viz: that recommended by the manufacturers and double that recommended. At double the recommended strength good results were obtained from each, the sprayed trees being free from scale in September, except one lot at Boonsboro, upon which Scalecide was used. No doubt the failure at this place was due to the fact that the oil did not emulsify properly, owing to the presence of some lime in the spray barrel which had just previously been used for applying lime-sulphur and salt.

At Laurel, both Kil-o-scale and Scalecide used at the recommended strength, viz: one part of the preparation to twenty parts of water, failed to give satisfactory results, as did also the former when used at the same strength upon twenty-five trees at Boonsboro. At Jessup, both gave apparently good results when used at this strength. It may be said, however, that at the latter place, check trees were left for comparison and these showed the scale to have multiplied to but a very slight extent even where left untreated.

TARGET BRAND SCALE EMULSION.

This preparation, which is a miscible oil similar to the two noted above, has not before been mentioned in publications of this Department, it being given its first trial the past season. One hundred and ten trees including both peach and apple at Boonsboro, thirty apple trees at Laurel and ten apple trees at Jessup were sprayed with it at the recommended strength and also five trees at Jessup with double that strength. Like Scalecide and Kil-o-scale, this preparation gave satisfactory results at the lesser dilution. Diluted according to directions, it gave good results on one plot (that at Jessup), but was quite unsatisfactory on the large plot at Boonsboro, and very poor on the one at Laurel. These results are too variable to warrant definite conclusions without further trial.

On the whole, experiments the past season have been slightly more favorable to the patent miscible oils than formerly. As has already been stated, however, the past season has been an exceptional one as regards the success of spraying for the San Jose scale. Examination of untreated trees in early spring showed about the usual per cent. of the pests to have survived the winter, but the extremely mild and open winter weather may have prevented their becoming as completely dormant as usual, thus rendering them less protected and consequently more susceptible to injury by the sprays. Certain it is that never before have any of the washes given such uniformly satisfactory results, as were indicated by the fall examinations. Undoubtedly, the frequent and heavy rains during the breeding period helped to some extent in the excellent showing made by most of the sprayed plots by washing the young scale from the trees before they could become securely fixed. Even the trees left untreated as checks in most cases did not show the usual multiplication of the scale during the summer. Taking into consideration the above facts together with the poor showing made by these washes when used at the recommended strengths upon the plots at Laurel and Boonsboro, it seems unsafe to attach much significance to the apparently good results obtained from them on the cooperative plots at Harman's. Used at the double strength they gave uniformly fair results, and orchardists contemplating using any of the mixtures would do well to bear this in mind. As formerly, however, it is the opinion of the writers that orchardists should be extremely careful and conservative about substituting any patent insecticide for the lime-sulphur wash which has so many times proven its reliability as a remedy for scale, and also in an efficient remedy for some fungous diseases. If any proprietary mixture continues to give satisfactory results we will be pleased to recommend it, cost, effectiveness, and other things being equal. For the present, however, we would advise anyone contemplating use of any of the above mixtures to at least double the strength recommended by the manufacturers.

DIRECTIONS FOR MAKING LIME-SULPHUR WASH.

In consideration of this wash we find from the reports of other experimenters, as well as from the results of our experiments for the past four years, that many variations in the quantities of each material used, and also many methods of boiling the wash, give uniformly satisfactory results. There is, therefore, considerable range both in quantity of materials and methods of making, which is decidedly a favorable factor in any insecticide, for seldom do farmers do similar work by the same methods and seldom do people interpret written directions or even speech in the same light, so that it is well that this wash will give good results under a variable interpretation of the directions for making and applying. As a whole, however, from the various combinations employed in our experiments with the mixture, we believe the following formula and directions for making to be the most satisfactory.

Stone lime	20 lbs.
Flowers or flour of sulphur	15 lbs.
Water to make	50 gallons.

NOTE:—While we do not consider salt a necessary ingredient of the wash, yet 10 pounds can be used if desired.

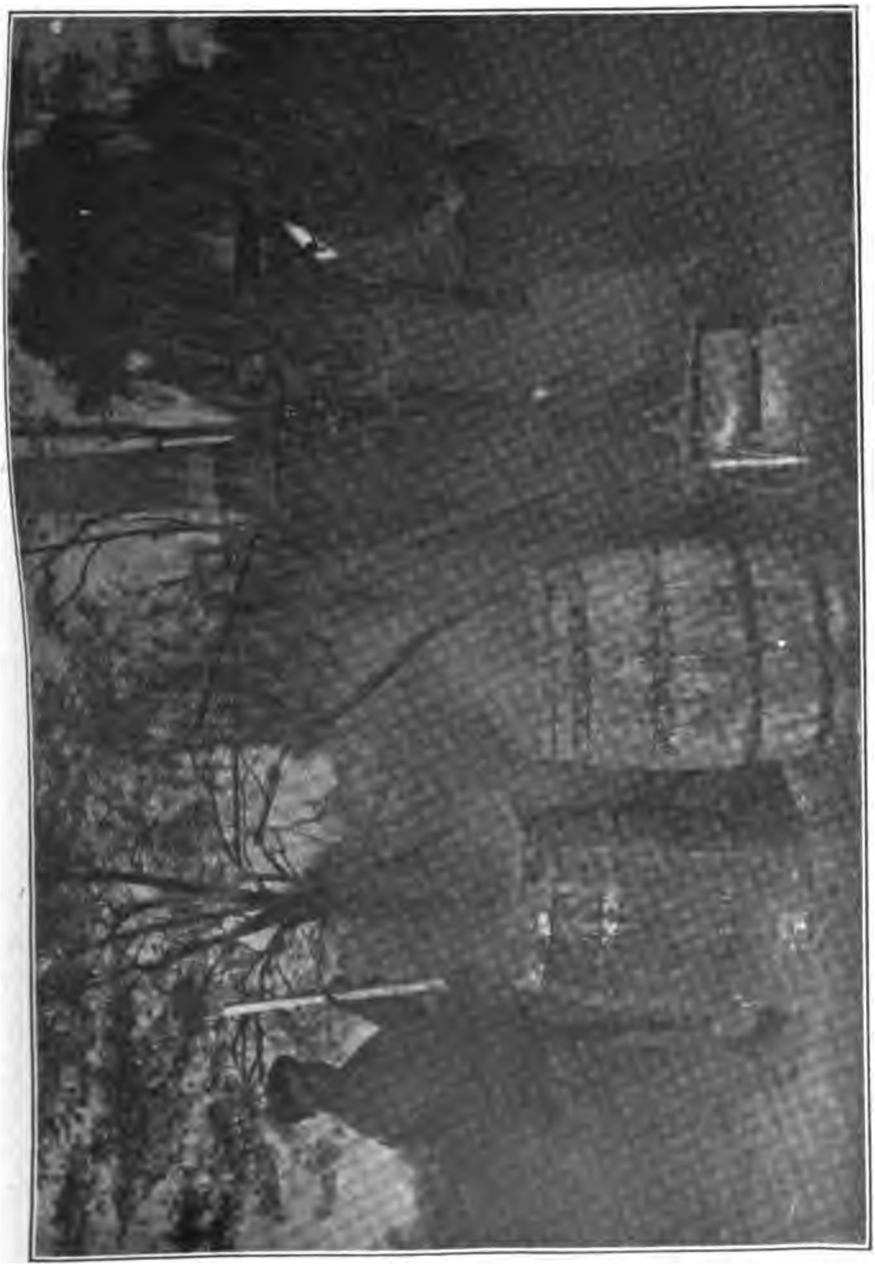

Figure 2.—Making lime-sulphur wash by steam. Photo. by Geo. P. Weldon.

Put twenty gallons of water in an iron vat or hog scalder and bring to a boil, then add the stone lime and sulphur. The sulphur should be made into a paste with hot or cold water before placing it in the boiler, in order to facilitate its mixing. After the lime and sulphur have been boiled for some time, salt may be added if desired. Boil the mixture, stirring occasionally, from thirty minutes to one hour or until the sulphur is thoroughly dissolved and a clear amber-colored solution produced. Then dilute by adding sufficient hot or cold water to make fifty gallons. Pass the mixture through a strainer with at least twenty meshes to the inch, into the spray barrel and apply to the trees warm.

BOILING THE WASH BY STEAM.

Owners of large orchards usually find it more convenient and less expensive to cook the wash by steam. In some cases an ordinary engine is hired or an ordinary boiler employed. In this manner, several

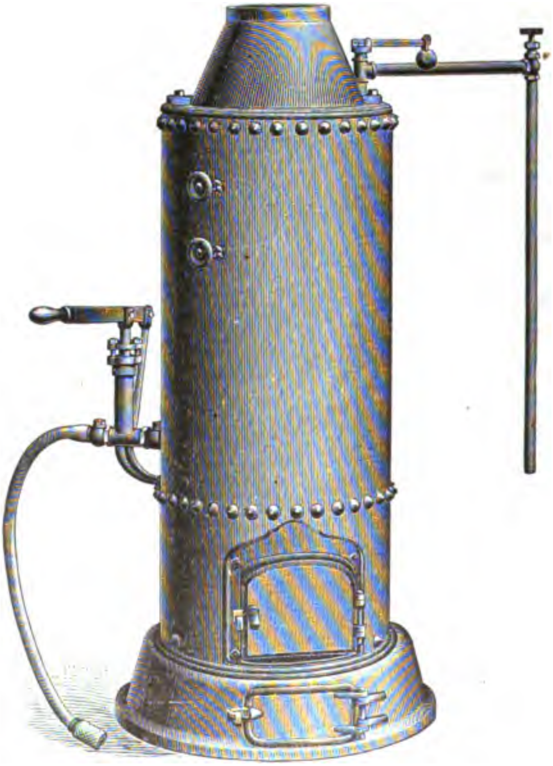

Figure 3.—Boiler for making the lime-sulphur wash by steam. Courtesy of Griffith & Turner, Baltimore, Md.

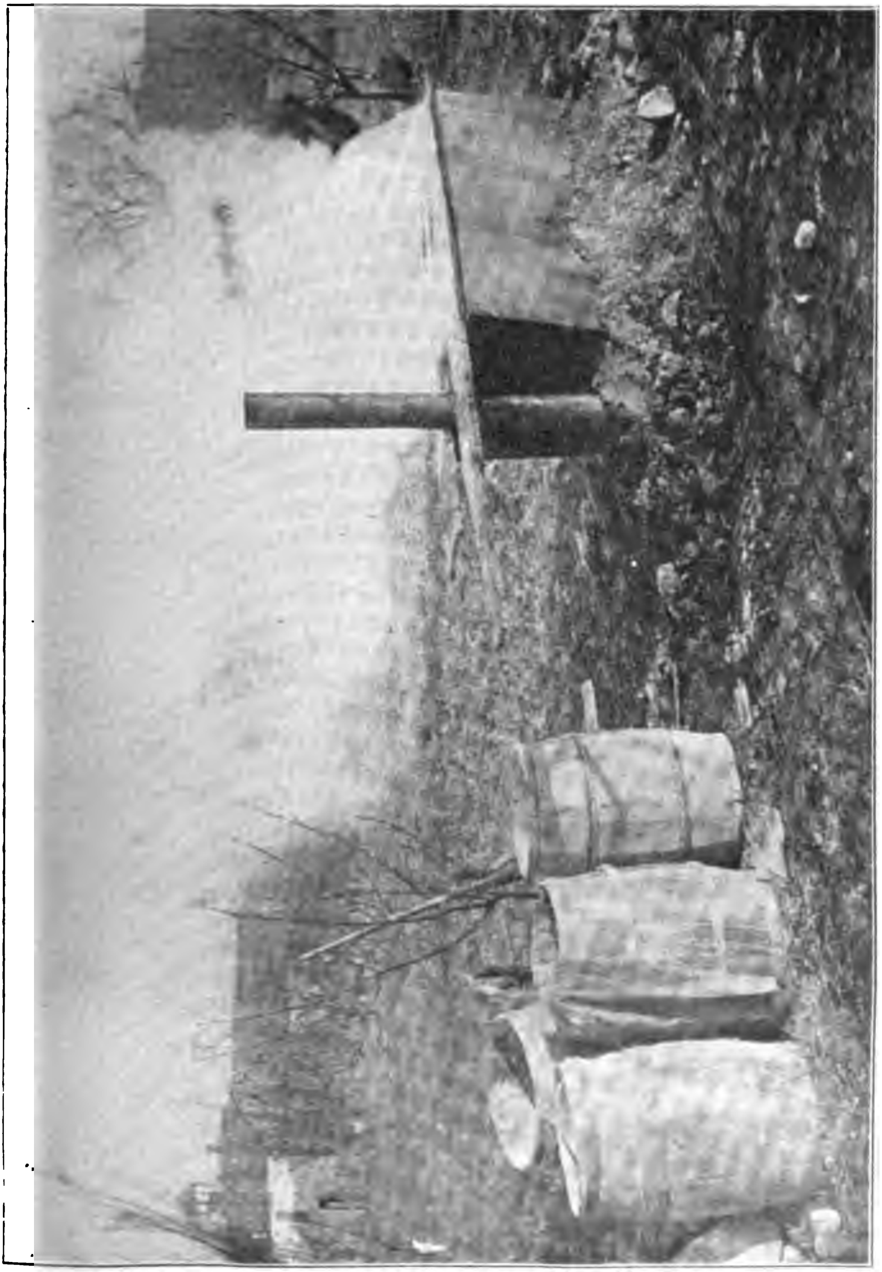

Figure 4.—A cheap and convenient way of making the lime-sulphur wash. Photo. by A. B. Gahan.

barrels of the wash can be made at the same time which facilitates the work where more than one pump is in operation. The steam pipe is extended along the top of the barrels, a branch pipe extending down into each barrel. This method of boiling the wash is not out of reach of the comparatively small orchardist, as a small, steam food-cooking boiler can be secured for about thirty dollars, which will serve to cook two or three barrels at a time. Figure 2 shows one of these small boilers, set up for work. It will be seen that the boiler is mounted on a truck and can be wheeled around to any place in the orchard or on the farm. There is no doubt that such an arrangement is very handy in making the wash and is not very expensive. The accompanying cut, Figure 3 shows one of these boilers.

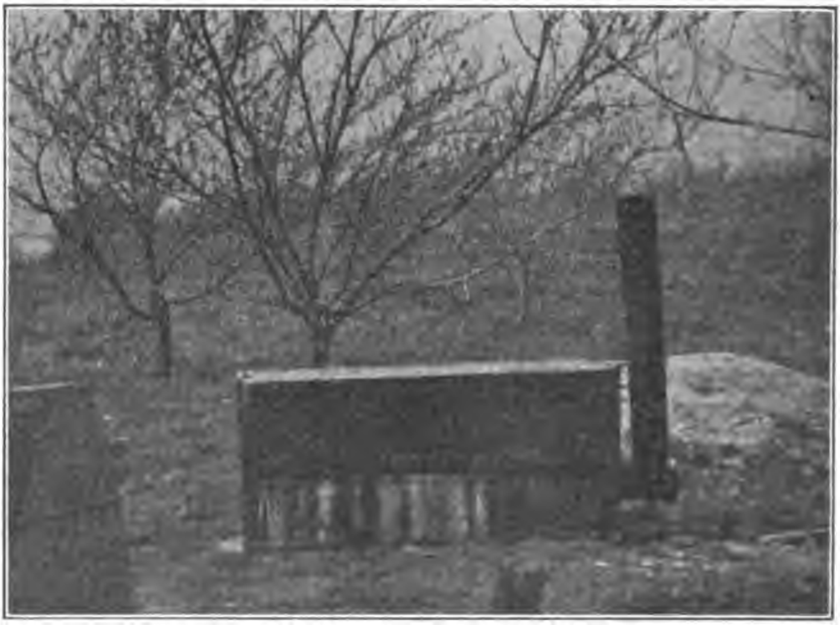

Figure 5.—Convenient vat for preparing lime-sulphur wash.
Photo. by T. B. Symons.

BOILING THE WASH IN A VAT.

The cheapest apparatus that can be employed for boiling the wash is that shown in Figures 4 and 5. Figure 4 consists of an old bath tub set in brick work with space for wood underneath. Figure 5 is a vat, the ends and sides of which are wood and the bottom sheet iron. The accompanying drawing, Figure 6, gives some idea of the dimensions and manner in which it should be built.

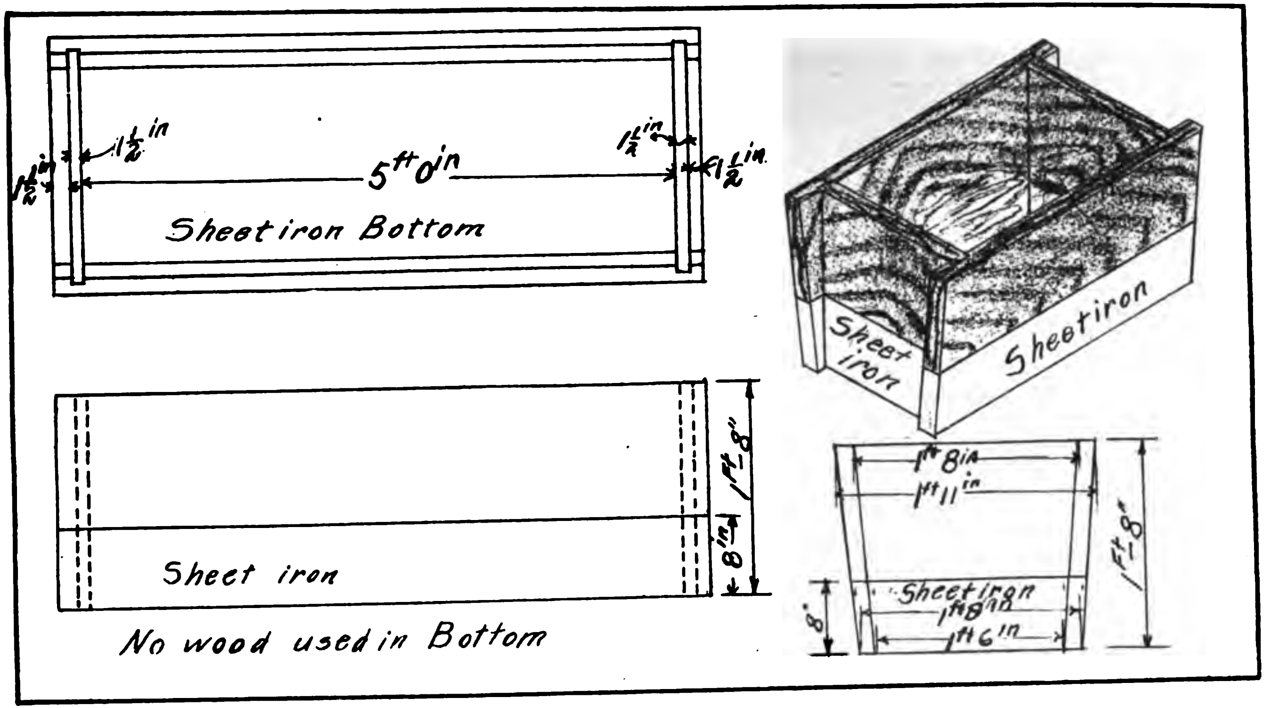

Fig. 6 Detail drawing of Vat.

This vat can be built for about $6.00 depending on the quality and the thickness of the lumber used. It is best to use at least 1½ inch stuff, 20 inches wide. Do not use two widths of boards on sides and ends. The sheet iron should not cost over $2.00. Be sure to allow the sheet iron to extend up the sides at least 6 inches, and especially on the end where fuel is put in the fire.

This vat can be placed over a hole in the ground about one foot deep and extending the whole length of the vat and fitted with a chimney of stove pipe at one end to carry off the smoke. Some orchardists prefer making a fire box out of sheet iron, having no top (as shown in Figure 7, with the vat at the side of the fire box) and setting

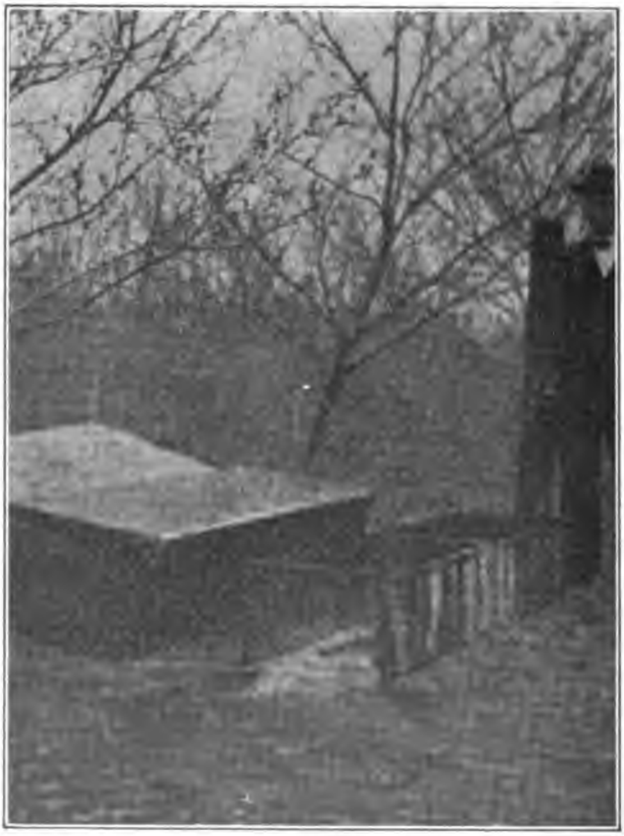

Figure 7.—Showing sheet-iron fire box.
Photo. by T. B. Symons.

the vat on this instead of making a hole in the ground. The fire box and vat shown in the figure, cost the owner, Mr. H. R. Fuss, of Union Bridge, Md., $4.00. Taking in connection the use of such an arrangement on the farm for other purposes, we believe it is the cheapest and most satisfactory apparatus for boiling the lime-sulphur wash.

DIRECTIONS FOR MAKING LIME, SULPHUR AND CAUSTIC SODA.

When it is impracticable to cook the solution as described above, one can be made as follows without cooking which can be expected to give fair results.

Formula:

Good quality, freshly burned, stone lime........	20 lbs.
Flowers or flour of sulphur	15 lbs.
Caustic soda	10 lbs.
Water	50 gallons.

Mix the sulphur with a small amount of water to form a paste, then add the lump caustic soda gradually to the sulphur paste. When the sulphur is all dissolved, pour this solution with enough water to keep from burning upon the stone lime, and allow the same to thoroughly slake, keeping the heat confined as much as possible by placing a sack over the barrel. Dilute with cold water to make 50 gallons and strain into the spray barrel.

TIME OF APPLICATION.

As stated in the discussion of this year's experiments, we were unable to draw a conclusion from the results of the washes applied at different times during the dormant season, as all were uniformly effective. However, it is our opinion, based on observation during the past four years, that when only one application is made, the treatment should be deferred until as late in the spring as possible, owing to the fact that the effectiveness of the wash depends to a great extent upon its presence on the trees after the breeding season begins. In bad infestations, especially on apple trees, it is best to make two applications, one in the fall and the other in the spring just before the buds open. In all cases, of course, the solution should be applied while the trees are comparatively dormant. However, in cases of necessity, those having very large orchards and extra work to do in the spring can do the spraying in the early fall when there is usually good weather for spraying, or it may be done on fine days during late winter.

MODE OF APPLICATION.

Not only should this wash be made properly, but the results to be expected depend largely upon the thoroughness of application. The scale being distributed over all parts of the tree makes it necessary that all parts of the tree be sprayed with the solution. It is always advisable to be particularly careful that the terminal branches and twigs of infested trees are coated as the young insects invariably locate on the tender wood. Often it is necessary to touch up these parts after the spray has dried on the trees. This is one advantage of the lime and sulphur wash, that the trees show as if whitewashed after treatment and many parts missed can be easily detected.

Where infested trees have been found here and there in an orchard, the scale is in all probability much more generally distributed than an inspection would ordinarily indicate. Under these circumstances, the whole orchard should be sprayed.

The majority of the spray pumps on the market will give satisfaction. In selecting a pump it is desirable to get one with all its working parts brass and which permits a constant high pressure in addition to being as simple in mechanism as possible. We believe the most economical pump, even for large orchardists, is the barrel pump, sold by various firms the names and addresses of whom will be given.

Where power or double acting spray pumps are desired, they also can be secured from the firms listed below. It is advisable to secure catalogs from all of them and select the pump best suited to your tastes and needs. The same may be said of selection of nozzles,—the desire being to have a nozzle that will throw a fine, mist-spray and one that is easily cleaned. Also in ordering a pump, make it a point to order sufficient hose, at least twenty-five feet to a lead. This will facilitate the work in allowing the sprayman to reach all sides of the trees without moving the pump and barrel. In addition it is usually desirable to have extension rods of either iron or bamboo to attach to the hose.

Applying the lime-sulphur wash is somewhat disagreeable unless the sprayman is properly fitted out with rubber or oil-skin coat, hat and gloves. It is a good plan to rub some vaseline on the hands and face, to prevent the spray from irritating the flesh. If the proper apparatus is used, there need be no more trouble in spraying trees with this solution than with other insecticides.

The following are manufacturers and dealers in pumps and supplies:

Griffith and Turner, Baltimore, Md.
Goulds Manufacturing Company, Seneca Falls, N. Y.
The Deming Company, Salem, Ohio.
Morrill and Morley, Benton Harbor, Mich.
Field Force Pump Co., Elmira, N. Y.
Myers Pump Co., Ashland, O.
George H. Stahl, Quincy, Ill.
Spray Motor Company, Buffalo, N. Y.
L. G. Orndorff, 203 7th St., N. W., Washington, D. C.
F. W. Bolgiano and Co., 935 M St., N. W., Washington, D. C.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 113. DECEMBER, 1906.

TOMATOES.

TESTING VARIETIES, CULTURE, TRAINING AND SPRAYING.

By T. H. White and W. R. Ballard.

Introduction.

The tomato crop, being a very important one in this State, has always received considerable attention at this Station. Several bulletins and reports have been published, all of which are now exhausted. While it is the intention of the present report to give the details of experiments only since the year 1897, still it has been thought well to include the summaries of the work published in former bulletins. While the work primarily has been that of testing varieties and spraying with Bordeaux mixture as a preventive of blight, still there are one or two other important items that have cropped out as the work progressed, and these will be considered in the proper place.

A few observations upon methods of culture have been included for general information.

Tomatoes, like many others of our cultivated plants, being the product of many generations of high culture and selection, must have suitable conditions for their development in order to be a profitable crop. There is no doubt that more of the new and profitable varieties originate under average or medium conditions than in the extremes, either way. It would hardly be expected that a good variety would originate on very poor soil. Neither would this be likely to occur on very rich soil, because of the tendency toward excessive vegetative growth.

Since this condition would apply as well to the general crop, the aim should be to secure average conditions. Land that would produce from ten to twelve barrels of corn per acre should, other things being properly looked after, easily produce six to eight tons of tomatoes. This would be called average or medium conditions.

SOIL.

Almost any soil from sand to clay will produce good crops of tomatoes, but here again extremes should be avoided and except under special conditions, such as where very early markets are to be supplied, it will be better to avoid the very light sandy soils. The soil must be in a good state of cultivation. Manures, fertilizers, lime, and the growing of clover or other legumes all help to bring about this condition. If a sod field is to be used, plow in the late fall or early spring and replow, cutting but a shallow furrow, in time to prepare for planting. Do not plant tomatoes on a piece of land which has had corn upon it the previous year, but rather let corn follow the tomatoes and later wheat or some other grain crop with grass and clover. Many farmers expect to get good tomatoes upon thin, sour land. Blight and disease in unfavorable seasons are always rampant upon such land and the grower becomes discouraged and is convinced that his soil is unsuitable for the crop, when, in reality the failure is due to a condition readily rectified by the application of lime and manure.

LOCATION.

For early market purposes hillsides banked on the North by woods and gently sloping to the Southward will give the best results, but for the general crop for canning purposes the location is not important provided the soil is well drained. It is well, however, to avoid low pockets of land where the air drainage is poor and into which, if the nights happen to be cool and moist, the dampness will settle, forming heavy dews, a condition not only liable to induce leaf diseases but also to prove detrimental to the ripening and dissemination of pollen. A full crop of fruit is absolutely dependent upon a good set and, if the air could be dry at all times it would go a long way towards insuring pollenization, the desired end.

MANURES AND FERTILIZERS.

It is almost impossible to give explicit directions for the proper manuring of a tomato field. This is largely a question of previous treatment and must come from a knowledge of the land and from the experience which the grower has had in handling it.

Stable manure at a dollar per ton is probably the cheapest fertilizer known. This at the rate of twenty (20) tons to the acre can be plowed down in the fall in a fresh state or rotted and applied before replowing in the spring. If the supply of stable manure is limited it can be used in smaller quantities in combination with commercial fertilizers and often give better and more economical results than by the exclusive use of either of them. If stable manure is out of the question commercial fertilizers may be used and if applied on a sod field that has been fall-plowed will give excellent results.

The best way to obtain a reliable fertilizer is to buy the materials and to mix it at home. In most cases a fertilizer that will analyze in nitrogen, phosphoric acid and potash relatively about the same as barn-yard manure will give the best results. See, however, that some of the nitrogen is in a form readily available, preferably in nitrate of soda. Some of the ingredients that can be used to make fertilizers at home are:

Phosphoric acid.	Nitrogen.	Potash.
Dissolved phosphate rock.	Nitrate of soda.	Muriate of potash.
Raw bone.	Sulphate of ammonia.	Sulphate of potash.
	Dried blood.	Kainit.
	Tankage.	
	Dried fish.	

Formula for mixing:

Dissolved phosphate rock	600 pounds.
Dried blood or tankage	900 pounds.
Nitrate of soda	300 pounds.
Muriate of potash.	200 pounds.
	2000 pounds.

This mixture would analyze approximately:

Nitrogen	6%
Phosphoric acid	4 to 5%
Potash	5%

This is a good formula for use without manure and should be applied at the rate of 500 pounds to 750 pounds per acre. Part of it should be sown over the land with a drill and harrowed in, and part in the furrow before the list is thrown up for setting the plants.

If the land has been well enriched with manure all that will be necessary is to supply some readily available plant food to give plants a start. A good formula for this would be:

Dissolved phosphate rock	175 pounds.
Nitrate of soda	100 pounds.
Sulphate of potash	25 pounds.
	300 pounds.

This quantity should be applied per acre. It should be applied in the furrow before listing. If it is found more convenient to use raw bone meal or sulphate of ammonia in the first formula, these may be substituted for the dissolved S. C. rock and nitrate of soda, but for sowing in the row on manured land the second formula will be found preferable.

SEED.

It pays to have good seed from good stock and if possible it will be well to procure the supply from the originator's own growing. There is no doubt that a variety which has passed from the originator's hands and into the hands of ordinary seed growers, who are not familiar with the ideal type as first selected, is sure to change it and perhaps for the worse. Therefore, if the originators are growers, try to get seed from them.

GROWING SEED.

To growers who save their own seed, and this may be profitably done in most cases, attention is called to the fact that careful notice should be taken of a few plants that seem to be just the type that is wanted and seed saved from these. The practice of picking out all the large and finest fruits is not recommended, because very often when the fruit is large the yield is not proportionately so. An illustration of this occurred a few years ago. The tomato called "Enormous" (see table VIII) was sent out. The plant was not at all branching, the stem and foliage being thick and heavy. The blossoms came in clusters of two, of which usually only one fruited. As a result the fruits produced were comparatively few in number but of large size, averaging throughout the season eight ounces apiece. This gave a yield of something less than two tons per acre. On the other hand. the variety "Freedom" which was small fruiting, but quite branching and free flowering in habit, gave fruits averaging three ounces in individual weight and over twelve tons per acre.

The necessity of care in the selection of the plant rather than the fruit is therefore quite apparent.

METHODS OF GROWING PLANTS.

There are two methods in general use in the production of tomato plants to be set in the fields about May 10. The hotbed method is used entirely for early crops. Wooden boxes or frames so-called are set up upon a pile of fermenting material, usually horse stable-manure, which is covered with an inch or two of rich soil. Seed is sown from the first of February to the first of March. The boxes are covered with glazed sash which are daily lifted to allow the plants a proper amount of air in order to produce stocky plants, which when three or four inches high are transplanted into other frames of rotted manure and rich soil. No heating material is used in the transplanting beds; as with some night cover the sun gives sufficient heat. Plants are set four to six inches apart each way and are quite large by the time the weather is suitable for planting out. They may then be cut out with a four inch block of soil and set in the field.

The other method of growing plants in the open air is simply a matter of selecting a suitable location, generally in the shelter of some big woods. The plot is carefully cleaned and prepared by plowing in a quantity of short well-rotted manure. A quick acting fertilizer is then applied and chopped or raked in. Pathways or alleys are marked, leaving beds about four feet wide upon which the seed is sown thinly broadcast. If plants come too thickly they should be thinned as they are weeded. Tobacco-bed sheeting or plant-bed cloth must be used to keep away the small flea-beetle which will do untold injury in the cool dry weather of early spring. These plants are pulled as soon as the weather is settled in May and set out with a peg or dibble on the prepared lists.

The experiments and observations of the past few seasons at this Station plainly indicate that a transplanted plant set out the 10th of May will yield almost double that of the later sown plant pulled from the seed-bed and set out on the same date. The latter part of recent summers have, however, been very wet and the early grown plants have had the advantage of the drier weather in the early summer months in which to bloom and set fruit. Whether, on an average, the hotbed method of growing plants would give the greater yield is a question that will take several experiments to decide. Even then it is questionable whether it would be possible to make it a paying investment as it would take quite an extensive outlay for glass in which to transplant plants enough for a large acreage.

DISTANCE APART.

This depends somewhat upon the variety and the method of cultivation to be followed. If the variety is only a medium grower, like "Sparks' Earliana" and is to be trained to a stake or a pole, one foot apart in the row and four feet between the rows will be satisfactory. If the ordinary culture is followed and the plants allowed to trail naturally over the ground, two and one-half feet apart in the row and three and a half to four feet between the rows will be about right. With the larger growing varieties two feet apart in the rows and four feet between the rows will be required for poles and four by five feet for ordinary culture on land that will produce eight or more tons per acre, while thinner land than this can be set four by four or three by four. Check rows should be made as this will save labor in cultivating. The wide way of the rows should be arranged to suit the run of the field in order that the pickers may gather the fruit without tramping on the vines.

CULTIVATION.

If the soil is moderately stiff and has in it very little fibre from rotten sod or manure so that it is inclined to become hard and compact between the time of preparation and the first cultivation it may be made mellow and friable by the use of the mould-board or barshare plow throwing the earth away from the row both ways, then working by means of cross cultivation with the toothed cultivators. Cultivation should be continued both ways as late as possible without injuring the plants.

SPRAYING EXPERIMENTS.

So much has been said, written, and indeed proved by experimenters about the increased yields and improved qualities of not only tomatoes, but also other vegetable and fruit products, that it seems scarcely necessary to enlarge upon the subject here. There is no doubt that under favorable conditions a fair crop annually is reasonably sure without spraying. In any event spraying is a preventive measure rather than a cure and must be commenced early in order to be effective. Spraying will not prove satisfactory if the soil is unsuitable, poorly fertilized, or low and wet.

The experiments recorded here are a continuation of similar work reported in Bulletin No. 54.

The seed for the year 1898 were sown in the cold frame April 8, and set in the field May 25. The plots contained 100 square feet with five plants to a plot. The plants on the sprayed portion received one application in the seed bed and two in the field. It is shown by Table I that the sprayed plot had a very large proportion of green fruit at the end of the season, the spraying evidently keeping the plants in a growing condition for a longer period than those which were unsprayed. The sprayed plots gave a heavier yield of ripe fruit.

TABLE I.--TOMATO SPRAYING EXPERIMENTS, 1898. SIZE OF PLOTS 100 SQ. FT.

	VARIETIES	Sprayed						Unsprayed						Increase or Decrease of Yield on Sprayed Plots, Ripe Fruit, Tons
		Ripe Fruit					Green Fruit	Ripe Fruit					Green Fruit	
		Date of First Picking	Date of Last Picking	Number of Fruits Per Plot	Average Weight of Fruits, ozs.	Yield Per Acre in Tons	Yield Per Acre in Tons	Date of First Picking	Date of Last Picking	Number of Fruits Per Plot	Average Weight of Fruits, ozs.	Yield Per Acre in Tons	Yield Per Acre in Tons	
1	Prizetaker	9/12	10/21	107	4.4	6.1	8.0	9/5	10/21	103	3.9	4.1	.3	+1.9
2	Royal Red	9/20	10/21	89	4.0	4.8	8.0	9/5	10/21	64	4.5	3.9	1.2	+ .9
3	Stone	9/12	10/21	68	6.1	5.7	8.7	9/20	10/21	48	3.8	3.0	1.3	+2.7
4	Favorite (G. & T.)	9/5	10/21	128	4.0	6.6	7.0	9/12	10/21	144	3.6	6.7	2.8	— .1
5	Paragon	9/20	10/21	64	5.8	5.0	6.7	9/12	10/21	51	5.8	3.9	3.5	+1.5
6	Beauty	9/5	10/21	103	3.8	5.3	7.0	9/12	10/21	48	4.8	3.1	3.4	+2.1
7	Matchless	9/5	10/21	83	3.8	4.4	5.5	9/5	10/21	91	4.1	5.5	2.4	—1.1
8	Favorite (Liv.)	9/5	10/21	82	4.2	4.7	7.9	9/20	10/21	93	4.1	5.2	5.2	— .5
9	Golden Queen	9/5	10/21	129	3.1	5.5	5.7	9/5	10/21	133	4.4	7.9	2.7	—2.4
10	Buckeye State	9/5	10/21	180	3.7	9.2	6.4	9/5	10/21	115	2.5	4.0	1.5	+5.2
11	World's Fair	9/12	10/21	80	4.5	4.8	6.3	9/12	10/21	67	4.1	3.7	2.2	+1.1
12	Queen	9/12	10/21	88	5.0	6.0	4.1	9/12	10/21	41	5.2	2.9	2.7	+3.6
13	Imperial	9/12	10/21	89	4.1	5.0	5.2	9/20	10/21	84	3.4	3.9	2.1	+2.1
	Aver. for all varieties	......	......	91	4.3	5.6	6.7	......	......	83	4.1	4.4	2.4	+1.3

The seed in the year 1899 was sown in the hotbed March 4, pricked out into cold frames April 5, and set into the field May 12. Table II shows an increase of over one ton per acre on the sprayed portion. The results of the two years work are in accord with the work done previously and the indications are that spraying could be made profitable.

TABLE II.—TOMATO SPRAYING EXPERIMENT, 1899. SIZE OF PLOTS 40 SQUARE FEET EACH.

	VARIETIES	Sprayed					Unsprayed					Increase or Decrease on Sprayed Plots, Tons
		Date of First Picking	Date of Last Picking	Number of Fruits	Average Wgt. Fruit, Ozs.	Per Acre, Tons	Date of First Picking	Date of Last Picking	Number of Fruits	Average Wgt. Fruit, Ozs.	Per Acre, Tons	
1	Stone	7/8	8/21	122	4.0	16.8	7/24	8/21	146	3.9	24.7	—7.9
2	Beauty	7/24	8/21	99	4.5	15.2	7/24	8/21	74	4.5	11.4	+3.8
3	Imperial	7/18	8/21	78	5.0	13.5	7/18	8/21	76	4.0	10.3	+3.1
4	Royal Red	7/18	8/21	98	5.0	16.8	7/18	8/21	70	5.0	12.2	+4.7
5	New Favorite	7/18	8/21	78	3.7	9.9	7/18	8/21	57	3.9	7.6	+2.3
6	Burpee's Climax	7/18	8/21	75	3.5	9.1	7/18	8/21	79	4.1	11.1	+1.9
7	Turner's Hybrid	7/18	8/21	61	5.4	11.4	7/18	8/21	62	5.1	10.9	+ .4
8	Perfection	7/24	8/21	62	3.6	7.6	7/18	8/21	40	4.8	6.6	+ .5
9	Paragon	7/18	8/21	101	2.7	9.5	7/18	8/21	66	3.5	8.1	+1.3
10	Acme	7/24	8/21	70	4.1	10.2	7/24	8/21	31	3.0	3.2	+6.9
11	Ignotum	7/18	8/21	63	3.9	8.4	7/18	8/21	106	3.2	11.6	—3.2
12	Crimson Cushion	7/24	8/21	56	8.0	15.2	7/24	8/21	37	5.8	7.4	+7.8
13	Fordhook Fancy	7/8	8/21	75	2.8	7.2	7/8	8/21	56	2.7	5.2	+1.9
14	Matchless	7/18	8/21	74	4.2	14.2	7/18	8/21	94	4.2	13.7	+ .4
15	Long Keeper	7/18	8/21	105	3.2	11.2	7/18	8/21	68	3.3	7.7	+2.5
16	Truckers' Favorite	7/18	8/21	81	3.6	10.3	7/18	8/21	78	4.7	12.7	+2.4
17	Enormous	7/18	8/21	32	7.4	8.9	7/31	8/21	21	7.1	5.1	+2.9
18	Ex. Ey. Purple Advance	7/18	8/21	150	2.2	11.2	7/24	8/21	110	1.9	7.5	+3.6
19	White's Excelsior	7/24	8/21	82	4.1	11.5	7/24	8/21	76	4.4	11.4	+ .2
20	Combination	7/8	8/21	72	2.7	6.8	7/8	8/21	69	3.3	7.8	—1.0
21	Freedom	7/8	8/21	138	2.5	11.9	7/8	8/21	114	2.5	9.8	+2.2
22	The Early Bird	7/28	8/21	214	1.5	11.5	6/28	8/21	176	1.9	10.7	+ .8
23	Buckeye State	7/24	8/21	57	6.1	11.9	7/24	8/21	72	5.0	12.4	— .5
	Aver. of all varieties	....	....	88	4.0	11.9	....	....	77	3.9	9.7	+1.6

Some varieties seem to be much more susceptible to blight than others so that in 1901 a variety of this character, Sparks' Earliana, was planted to test the value of spraying with the Bordeaux mixture. Table III gives the record of this experiment and shows a large increase in favor of spraying both on poles and under ordinary culture.

TABLE III.—SPRAYING EXPERIMENT WITH SPARKS' EARLIANA TOMATO, 1901.

	Sprayed		Unsprayed		Difference in Favor of Spraying	
	Tons	Pounds	Tons	Pounds	Tons	Pounds
Trained on poles	30	463	25	1790	4	673
Ordinary field culture..	14	410	9	209	5	201

TRAINING EXPERIMENTS.

This experiment was an investigation as to the relative value of the methods of culture, "Trained to a single stem on poles," vs. "Ordinary field culture." The plants trained on the poles had all the side shoots kept off and the main stem tied to a pole. These plants were set three feet apart in the row and four feet between the rows. Those under ordinary field culture were set the same distances apart as those on the poles, but were allowed to run at will upon the ground. The season was a very poor one and but little fruit set. Although Table IV shows less fruit to the plant on the poles than on the plants under ordinary cultivation, they weighed somewhat heavier.

TABLE IV.—SHOWS YIELDS OF VARIETIES TRAINED TO ONE STEM ON POLES VS. ORDINARY FIELD CULTURE, 1900.

	VARIETIES	Pruned and Trained on Poles					Ordinary Field Culture				
		Date First Picking	Date Last Picking	No. of Fruits	Average Weight of Fruits, oz.	Per Acre, tons	Date First Picking	Date Last Picking	No. of Fruits	Average Weight of Fruit, oz.	Per Acre, tons
1	Prizetaker	8/16	9/21	9	5.6	1.7	8/16	9/7	13	4.4	1.9
2	Acme	8/16	9/7	11	5.8	2.1	8/31	9/7	6	4.3	.8
3	New Queen	8/16	9/21	12	4.2	1.7	8/16	9/21	11	3.7	1.3
4	Stone	8/16	9/7	12	5.3	2.2	8/31	9/21	18	4.2	2.5
5	Beauty	9/7	9/7	2	2.5	.2	8/16	9/21	11	3.7	1.3
6	Buckeye State	8/31	9/7	3	11.0	1.1	8/31	9/7	3	5.0	.5
7	Paragon	8/16	9/21	9	5.8	1.8	8/16	9/7	11	5.3	2.0
8	Perfection	8/16	9/21	10	5.2	1.7	8/16	9/7	19	3.6	2.3
9	Ponderosa	8/16	8/31	3	3.3	.3	8/23	9/21	8	5.0	1.3
10	New Favorite	8/16	9/7	7	5.2	1.2	8/7	9/21	4	4.0	.5
11	Truckers' Favorite	8/23	9/21	5	9.4	1.5	8/23	9/7	11	5.5	2.0
12	Ignotum	8/16	8/31	4	6.5	.8	8/16	8/31	7	4.7	1.1
13	Climax	8/16	8/21	12	4.5	1.8	8/16	9/7	15	3.7	1.9
14	Ex. Ey. Purple Advance	8/23	8/21	25	1.4	1.2	8/23	9/21	19	3.1	2.0
15	White's Excelsior	9/7	8/21	2	6.5	.4	....	....	....	....	....
16	Long-Keeper	8/23	8/21	7	4.0	.9	8/31	9/21	2	6.5	.4
17	Enormous	....	....	....	....	....	8/31	9/7	2	8.5	.5
18	Matchless	8/16	9/7	5	6.6	1.1	8/23	9/7	1	11.0	.3
19	Crimson Cushion	8/31	8/31	4	8.7	1.2	8/7	9/7	2	5.0	.3
20	Freedom	8/16	9/21	7	4.7	1.1	8/23	9/7	14	4.0	1.9
21	Imperial	8/16	9/7	9	5.3	1.6	8/16	9/7	2	4.0	.3
	Averages	....	....	8	4.9	1.3	....	....	8.8	4.2	1.2

The following season the same experiment was tried, using only one variety, Sparks' Earliana. The plants on poles were set only one foot apart in the row and four feet between rows. Table V shows that the trained plants gave an increase of sixteen tons over plants of the same variety set 2½x4 ft. and allowed to run over the ground.

TABLE V.—METHODS OF CULTURE AND TRAINING TOMATOES. SHOWS RESULTS WITH SPARKS' EARLIANA TRAINED ON POLES VS. ORDINARY FIELD CULTURE.

	Per Acre Tons	Per Plant Lbs.	Per Plant Oz.
Trained on poles, 1 foot apart, 4 feet between rows, 10,890 plants	**30.2**	**5**	**9**
Ordinary field culture, 2½ feet apart, 4 feet between rows, 4,356 plants	**14.2**	**6**	**7**

A comparison of these tables will show that the increased yields come not so much from the difference in the manner of growth as from the larger number of plants it is possible to set upon an acre when the vines are tied to stakes. Under some special conditions favorable to the production of early crops, where an abundance of small undergrowth suitable for stakes could be readily secured in the woods, this pole method could be made very profitable. In private gardens, too, where land is valuable and limited in amount and where a neat appearance is desired, this method could be recommended.

VARIETY TESTS.

Novelties are constantly making their appearance and disappear as quickly, if not adapted to the needs of the grower. It would seem advisable, then, to publish the results of the variety tests annually in order that the value of these novelties might be quickly known. Such a plan, however, is open to criticism, because the growing of a variety for only one year is not sufficient to determine conclusively the merit of a new variety. The fact, too, that the great range of conditions found in the State has an important bearing upon the success or failure of a variety, makes it apparent that the Station might devote its energies to other lines of investigation with more valuable results. Much interesting information, however, may be derived from the running of variety tests over a series of years. In the work at this Station it can be seen that the new varieties are usually great yielders. In many cases after a few years they apparently run out and are replaced by others. These new varieties are often not much different from those which have gone before, but they usually run very high in yield for the first few years. As an illustration "Ignotum" was introduced in the season of 1890, and that year produced in our tests at the rate of 19 tons, 81 lbs, per acre. This was a new variety, which had been selected by Professor Bailey, in 1887, from a German strain. In 1899 it had dropped to fourth place in point of yield and at present is little known. In 1904 the tomato "Five Million Dollars," introduced by Salzer, gave the largest yield of tomatoes of its type. The following season it was still in the lead, but it dropped to nearly half its former yield in 1906, while the "Greater Baltimore," a new variety of similar character, had taken the lead with a yield of nearly 25 tons per acre.

These results can be accounted for, in some cases at least, by the fact that the stock passes from the hands of the originator and is allowed to revert and thus loses its value as a large yielder. The variety work thus shows how important it is to "rogue" and to "select" so as to keep the stock up to the ideal set by the originator.

Tables VI-XI give the yields of all the varieties tested here since 1900 with the exception of the season of 1902, when complete records were not secured. In these tests the seed was sown in the hotbed about March 1, and the plants transplanted four inches apart in cold frames, the first week in April. They were set out in the field with a block of earth attached about the 10th of May. No spraying was done in these tests because it was thought advisable to give only ordinary farm conditions.

At the bottom of Table XI will be found a record of the yields of five varieties considered suitable for canning. These were given about the same culture as would be given the canning tomato crop by the average grower. The seed was sown in a sheltered location in April. The plants were simply pulled from the bed and set in the field in hills on soil similar to that of the early crop and under like conditions. This experiment will be continued as it has frequently been noticed that the plants sown earlier and transplanted into cold frames and again into the field with a ball of earth attached give much larger yields than plants from seed sown a month later and set directly into the field. A final report upon this matter may suggest better methods of growing plants for the ordinary grower.

TABLE VI.—COMPARISON OF THE VARIETIES OF TOMATOES TESTED IN 1900.
SIZE OF PLOTS 100 SQ. FT.

	VARIETIES	Date of First Picking	Date of Last Picking	Number of Fruits	Yield Per Plot Lbs.	Yield Per Plot Oz.	Average Weight Oz.	Yield Per Acre Tons
1	Beauty	7/13	9/4	199	44	7	3.5	9.5
2	New Queen	7/13	9/4	221	49	5	3.5	10.7
3	Royal Red	7/13	9/4	304	65	1	3.4	14.1
4	New Century	7/21	9/4	219	49	......	3.5	10.6
5	Maule's 1900	7/21	9/4	198	44	3	3.5	9.6
6	Matchless	7/21	9/4	289	57	......	3.1	12.4
7	Combination	7/21	9/4	270	46	......	3.8	10.0
8	Ennobled	7/21	9/4	237	55	14	3.7	12.1
9	Kansas Standard	7/21	9/4	158	32	10	3.3	7.1
10	J. E. Swift	7/21	9/4	176	38	1	3.4	8.2
11	Salzer's 1900	7/21	9/4	268	49	......	2.9	10.6
12	Quicksure	7/21	9/4	77	20	......	4.1	4.3
13	Spark's Earliana	7/21	9/4	96	16	1	2.6	3.4
14	Quarter Century	7/21	9/4	120	26	3	3.4	5.7
15	Magnus	7/21	9/4	176	32	8	2.9	6.9
16	Prizetaker	7/21	9/4	190	37	......	3.1	8.0
17	World's Fair	7/21	9/4	227	34	3	2.4	7.4
	Aver. for all varieties	......	......	190	38	6	3.3	8.6

TABLE VII.—COMPARISON OF THE VARIETIES OF TOMATOES TESTED IN 1901
SIZE OF PLOTS 100 SQ. FT.

	VARIETIES	Date of First Picking	Date of Last Picking	Number of Fruits	Yield Per Plot Lbs.	Yield Per Plot Oz.	Average Weight Oz.	Yield Per Acre Tons
1	New Imperial	7/10	8/20	136	32	6	3.8	7.0
2	Beauty	7/24	8/20	92	28	2	4.8	6.3
3	Acme	7/10	8/20	133	28	......	3.3	6.1
4	Fordhook First	7/10	8/20	103	26	4	4.0	5.7
5	Success	7/24	8/20	76	28	11	6.0	6.2
6	Burpee's Noble	7/10	8/20	62	18	7	4.7	4.0
7	World's Fair	7/10	8/20	66	21	11	5.2	4.7
8	Paragon	7/27	8/20	99	28	6	4.5	6.3
9	Stone	7/27	8/20	64	23	12	5.7	5.1
10	Enormous	7/10	8/20	9	3	7	6.1	.7
11	Magnus	7/10	8/20	57	20	3	8.4	4.3
12	Fordhook Fancy	7/10	8/20	44	8	9	3.0	1.8
13	Qnarter Century	7/10	8/20	69	14	1	3.2	3.0
	Aver. for all varieties	......	......	77	21	11	4.8	4.7

TABLE VIII.—COMPARISON OF THE VARIETIES OF TOMATOES TESTED IN 1903. SIZE OF PLOTS 100 SQ. FT.

	VARIETIES	Date of First Picking	Date of Last Picking	Number of Fruits	Yield Per Plot Lbs.	Yield Per Plot Oz.	Average Weight Oz.	Yield Per Acre Tons
1	Favorite	7/18	9/15	160	41	4	4.1	8.9
2	Matchless	7/18	9/2	100	29	13	4.7	6.4
3	Enormous	7/18	9/2	17	8	8	8.0	1.8
4	Paragon	7/18	9/15	120	35	3	4.6	7.6
5	Success	7/18	9/15	110	34	15	5.0	7.6
6	Beauty	7/18	9/2	126	34	8	5.0	7.5
7	Acme	7/18	9/2	223	50	5	3.6	10.9
8	Freedom	7/18	9/15	289	55	13	3.0	12.1
9	Chalk's Early Jewel	7/18	9/2	183	49	9	4.3	10.7
10	Landreth Early	7/18	9/2	189	48	3	4.0	10.4
11	Nolte's Earliest	7/18	8/15	194	46	4	3.8	10.0
12	Spark's Earliana	7/18	8/22	173	38	10	3.5	8.4
13	New, for trial	7/18	9/15	65	22	15	5.6	4.9
14	Ponderosa	7/18	9/2	90	31	12	5.6	6.9
15	Stone	7/18	9/15	50	16	4	5.2	3.5
16	Imperial	7/18	9/2	97	31	7	5.1	6.8
17	Washington	7/18	9/2	120	30	12	4.1	6.6
18	Dwarf Champion	7/18	9/2	151	36	10	3.8	7.9
19	Rawson's Puritan	7/18	9/15	158	44	......	4.4	9.5
	Aver. for all varieties	......	......	137	36	2	4.6	7.6

TABLE IX.—COMPARISON OF THE VARIETIES OF TOMATOES TESTED IN 1904. SIZE OF PLOTS 100 SQ. FT.

	VARIETIES	Date of First Picking	Date of Last Picking	Number of Fruits	Yield Per Plot		Average Weight	Yield Per Acre
					Lbs.	Oz.	Oz.	Tons
1	Beauty	7/16	8/29	234	120	14	8.2	26.7
2	Acme	7/9	8/29	379	99	......	4.1	21.5
3	Chalk's Early Jewel	7/5	8/29	302	99	11	5.2	21.7
4	Success	7/16	8/29	257	102	4	6.3	22.2
5	Sparks' Earliana	7/5	8/20	337	82	5	3.9	17.9
6	Five Million Dollar	7/16	8/29	333	118	3	5.6	25.7
7	Nolte's Earliest	7/5	8/24	357	115	......	5.1	25.0
8	Dwarf Stone	7/23	8/29	229	81	7	5.6	17.7
9	Vaughan's Model	7/16	8/29	225	56	6	4.0	12.2
10	Michel's Very First	7/9	8/20	202	53	2	4.2	11.5
11	Freedom	7/16	8/29	570	117	1	1.5	25.4
12	Magnificent	7/16	8/29	233	88	......	6.0	19.1
13	Rawson's Puritan	7/16	8/29	232	79	2	5.4	17.2
14	Tall Champion	7/16	8/29	253	84	12	5.3	18.4
	Aver. for all varieties	......	......	296	93	5	5.0	19.4

TABLE X.—COMPARISON OF THE VARIETIES OF TOMATOES TESTED IN 1905. SIZE OF PLOTS 100 SQ. FT.

	VARIETIES	Date of First Picking	Date of Last Picking	Number of Fruits	Yield Per Plot		Average Weight	Yield Per Acre
					Lbs.	Oz.	Oz.	Tons
1	Globe	7/8	8/14	97	56	14	9.0	12.3
2	Truckers' Favorite	7/8	8/14	256	101	1	6.3	21.9
3	Santa Rosa	7/8	8/14	177	112	5	10.1	24.4
4	Early Hustler	6/29	8/14	278	71	13	4.1	15.6
5	Paragon	7/14	8/14	247	102	4	6.6	22.2
6	New Magnificent	7/14	8/14	267	101	15	6.1	22.1
7	Acme	7/8	8/14	411	97	13	3.7	21.3
8	Five Million Dollar	7/14	8/14	356	116	5	5.2	25.2
9	Maule's Earliest	6/29	8/14	294	75	3	4.0	16.3
10	Tenderloin	6/29	8/14	323	130	......	6.4	28.2
11	Logan's Giant	7/8	8/14	160	82	12	8.2	18.0
12	Success	7/8	8/14	224	73	8	5.2	16.0
13	Chalk's Early Jewel	7/8	8/14	293	95	15	5.2	20.8
14	Liv. Beauty	7/8	8/14	399	107	14	4.3	23.4
15	Sparks' Earliana	6/29	8/14	203	72	11	5.7	15.8
16	Dwarf Stone	7/8	8/14	161	49	11	4.9	10.8
17	Buckeye State	7/14	8/14	177	81	13	7.4	17.8
18	Matchless	7/14	8/14	257	150	2	9.3	32.6
19	Stone	7/14	8/14	244	95	1	6.2	20.7
	Aver. for all varieties	......	......	254	93	1	5.9	19.4

TABLE XI.—COMPARISON OF THE VARIETIES OF TOMATOES TESTED IN 1906. SIZE OF PLOTS 100 SQ. FT.

	VARIETIES	Date of First Picking	Date of Last Picking	Number of Fruits	Yield Per Plot		Average Weight	Yield Per Acre
					Lbs.	Oz.	Oz.	Tons
1	Greater Baltimore	7/21	9/14	411	111	15	3.1	24.3
2	Stone	7/21	9/14	213	81	5	6.1	17.6
3	Chalk's Early Jewel	7/14	9/4	221	76	......	5.5	16.5
4	Livingston's Globe	7/14	9/14	197	65	7	5.0	14.2
5	Salzer's Bountiful	8/4	9/14	213	69	......	5.1	15.0
6	Success	7/21	9/4	192	67	5	5.3	14.6
7	Truckers' Favorite	8/4	9/14	219	81	6	5.9	17.7
8	Matchless	7/21	9/14	164	49	4	4.8	10.7
9	Five Million Dollar	7/14	9/7	183	59	10	5.2	12.9
10	Sparks' Earliana	7/21	8/18	227	56	8	3.9	12.5
11	Wood's Improved Ponderosa	7/21	9/7	100	55	5	8.8	12.0
12	Beauty	7/28	9/7	202	83	8	6.6	18.1
13	Acme	7/21	9/7	237	60	12	4.1	12.7
14	Burpee's Earliest Pink	7/7	9/7	138	39	12	4.6	8.6
	Late Planted							
15	Success	8/11	9/14	84	27	12	5.2	6.0
16	Five Million Dollar	8/11	9/14	90	24	......	4.2	5.2
17	Paragon	8/15	9/7	55	20	12	6.0	4.5
18	Matchless	8/11	9/14	84	30	......	5.7	6.5
19	Stone	8/11	9/14	63	21	2	5.3	4.5

Table XII gives the number of fruits and their weight in pounds and ounces for the pickings up to and including that of August 4, of fourteen varieties grown in the season of 1906. This gives a good idea of the comparative desirability of these varieties for early markets. Burpee's Earliest Pink would seem to be the most desirable in point of yield, with Sparks' Earliana next, and the others in their order.

TABLE XII.—COMPARISON OF EARLY TOMATOES, 1906. PICKINGS TO AUG. 4. SIZE OF PLOTS 100 SQ. FT.

VARIETIES	Number of Fruits	Yield Per Plot Lbs.	Oz.	Yield Per Acre Tons
Burpee's Earliest Pink	85	25	13	5.6
Sparks' Earliana	60	21	6	4.6
Greater Baltimore	57	19	3	4.1
Chalk's Early Jewel	50	16	6	3.5
Acme	35	10	..	2.1
Five Million Dollar	27	9	6	2.0
Success	16	6	12	1.4
Livingston's Globe	16	6	6	1.3
Matchless	16	6	2	1.3
Stone	16	5	14	1.2
Beauty	12	4	..	.8
Wood's Improved Ponderosa	5	2	10	.5
Truckers' Favorite	7	2	8	.5
Salzer's Bountiful	6	2	..	.4

AVERAGE COMPARATIVE YIELDS.

In Table XIII is given the yields of eighteen varieties of tomatoes for several years past. Some of these varieties have been tested for a period of eight years while others have been grown for a much shorter period. The last column gives a general average for the series of years, which indicates the comparative yields of the varieties.

TABLE XIII.—COMPARATIVE YIELDS OF TOMATOES PER ACRE.

	VARIETIES	1898 Tons	1899 Tons	1900 Tons	1901 Tons	1903 Tons	1904 Tons	1905 Tons	1906 Tons	General Average Tons
1	Five Million Dollar	....	....	....	....	....	25.7	25.8	12.9	19.2
2	Truckers' Favorite	....	6.6	....	....	....	....	21.9	17.7	16.0
3	Beauty	9.5	.7	9.5	6.3	7.5	26.7	23.4	18 1	15.1
4	Chalk's Ey. Jewel	....	....	....	....	10.7	21.7	20.8	16.5	14.9
5	Freedom	....	4.9	....	....	12.1	25.4	....	....	13.8
6	Acme	....	5.7	....	6.1	10.9	21.5	21.3	12.7	13.5
7	Stone	4 2	11.5	....	5.1	3.5	....	20.7	17.6	13 3
8	Matchless	8.9	7.3	12.4	....	6.4	....	32.6	10.7	12.1
9	Sparks' Earliana	....	....	3.4	....	8.4	17.9	15.8	12.5	11.9
10	Buckeye State	10.6	6.5	....	....	....	....	17.8	....	11.6
11	Royal Red	9 1	11.4	14.1	....	....	....	....	....	11.2
12	Paragon	9.6	5.3	....	6.3	7 6	....	22.2	....	10.2
13	Imperial	8.0	12.8	....	7.0	6.8	....	....	....	8.7
14	Favorite	11.3	4.7	....	....	10.1	....	....	....	8.7
15	World's Fair	8.6	....	7.4	4 7	....	....	....	....	6.9
16	Prizetaker	9.3	1.8	8.0	....	....	....	....	....	6.4
17	Enormous	....	4.5	....	.7	1.8	....	....	....	2.3

DESCRIPTION OF VARIETIES, 1906.

The Greater Baltimore is a handsome fruit of the same general type and color as the Stone, the so-called "red" or canning tomato. This seems to be a valuable addition to the list of varieties.

The Stone is too well known to need a description here.

Chalk's Early Jewel is a good variety for market or home use. It is fairly early and will yield larger crops and over a longer period than will Sparks' Earliana.

Livingston's Globe is a fine, meaty tomato. It is globe shaped and on this account is considered desirable for slicing for the table.

Salzer's Bountiful is a new and prolific variety, but is poor in color, being a yellowish red.

Success is of the same general type as Stone, Paragon, etc.

Truckers' Favorite is a purple tomato suitable for market although usually a little more irregular in shape than the Beauty.

Matchless is an old standard variety suitable for market or canning purposes.

The Five Million Dollar is of the same type as the Stone and has given heavy yields in the two years just past.

Sparks' Earliana is one of the earliest of the smooth, regular tomatoes, but it needs rich soil and close planting in order to get large crops for market or home use.

Wood's Improved Ponderosa is very much like the old Ponderosa with large fruits.

Livingston's Beauty is the old standard purple variety and is an excellent market sort where this color is in demand.

The Acme is similar to Beauty, but is earlier and not quite so large.

Burpee's Earliest Pink is similar to Acme or Beauty in color but is very early. It is too rough for a good market sort.

INTERESTING ITEMS ABSTRACTED FROM SUMMARIES OF PREVIOUS BULLETINS ON TOMATOES OF THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN NO. 11, DECEMBER, 1890.

Range of yield, 2 to 20 tons per acre, General average 11¾ tons. Selected varieties average 14 tons.

The best yielder was the "Ignotum," 19.81 tons per acre.

The greater the number of cells in the tomato the higher the percentage of solid flesh. An average of 10¾ cells per fruit gives 80 per cent. of flesh.

Pot-grown plants undisturbed from the seed do not damp off as easily as plants bed-grown and transplanted.

Pot-grown plants exceed transplanted plants in product 18 per cent. or at rate of two tons per acre.

In earliness or first months of bearing pot-grown plants yield double the others. For quantity of crop tomatoes should be well manured but it is not well to grow them on the same land successive years.

Better results generally followed the use of two fertilizing elements combined than one used alone, but potash alone gave good results, better than some mixtures.

Phosphoric acid alone had little effect on quantity of crop.

Nitrate of soda and muriate of potash can be recommended as special fertilizers for the tomato.

Potash fertilizers seem to decrease sugar and increase acid in tomatoes.

Phosphoric acid plots produced some of the sweetest tomatoes found.

Nitrogen and potash affect composition of fruit more than phosphoric acid.

The tomato is not a specially exhausting crop. Tomatoes do not remove as much plant food from soils as most farm crops at the usual rates of product per acre.

The refuse of the crop from an acre of tomatoes contains more fertilizing material than similar remains of most other crops.

The vines and roots of tomatoes are very rich in potash.

The residue of the tomato crop should be evenly spread and plowed under.

As regards economy of soil fertility the tomato crop is a desirable one to raise.

BULLETIN NO. 25, MARCH, 1894.

Healthfulness of stock from which to propagate is of the first consideration. Some varieties of tomatoes seem more susceptible to disease than others. Vigor of plant, productiveness, and quality of fruit should determine selection.

Judicious shipment in advance of local competition offers the largest promise of profit.

The economic use of commercial fertilizers is dependent on other supplemental conditions as well as the facts of the available plant food contained in them.

BULLETIN NO. 54, MARCH, 1898.

The best varieties for main crop trucking are Paragon, Prize Taker, Perfection, World's Fair and Climax.

The best varieties for the canning trade are Royal Red, Queen, Stone, Paragon, and Matchless.

The best variety for late market or family use is the Buckeye State.

The use of the Bordeaux solution proved an effectual means of holding the tomato leaf blight in check.

In 1896 spraying with Bordeaux solution four times produced, with 35 varieties, an average increase in yield of 2.5 tons per acre of marketable fruit.

In 1897 spraying with Bordeaux solution three times produced, with 19 varieties, an average increase in yield of 2.2 tons per acre of marketable fruit.

Some varieties are more susceptible to the blight than others. In 1896 all but one variety, and in 1897 all but three varieties gave an increased crop of ripe fruit as a result of spraying with Bordeaux solution, and all of the varieties showed an increase when the amount of green tomatoes at the end of the season was added.

The increase in crop as a result of spraying, ranged from ¼ of a ton to 6 tons in 1896, and from ¼ to 4¼ tons in 1897.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 114. JANUARY, 1907.

FERTILIZER EXPERIMENTS WITH DIFFERENT SOURCES OF PHOSPHORIC ACID.

BY H. J. PATTERSON.

The experiments reported upon in this bulletin were inaugurated in 1895. A report of progress on the tests was made in Bulletin No. 68, published in September, 1900. The object of the experiment was to test the availability of different sources and forms of phosphorous and methods of rendering insoluble phosphates available in the soil.

PLAN OF THE EXPERIMENTS CONDUCTED.

The general plan of the experiments consisted in the testing of the availability of different forms of phosphoric acid and means for rendering insoluble phosphates available in the soil. The idea in mind was to make these tests much more than a soil test of a particular farm, and they were so planned and conducted as to make the results applicable to most parts of this State, and of general interest to agriculture wherever commercial fertilizers are used.

The idea that pervaded the plan was to imitate nature and get the land as nearly as possible in the same condition it was when a virgin soil and then continue to use nature's methods for maintaining fertility.

It is well known from chemical analysis of soils that they contain sufficient phosphoric acid to furnish all that is needed for good crops for many years. It has also been shown that some soils which fail to produce satisfactory crops contain more phosphoric acid than those that are considered fertile. Now this difference in fertility must be due to a condition of availability.

An examination of the conditions which prevailed in virgin soils, or in any soil that has just been cleared of its forest growth, soon makes prominent the fact that nature has filled that soil with organic matter, this organic matter not only gives the soil a dark color and fine physical appearance but it also performs functions in producing chemical changes that cannot take place in that same soil were it destitute of organic matter. Again we find that a virgin soil will produce satisfactory crops for a number of years without the intervention of commercial fertilizers; but about as soon as the organic matter has been worked out, the soil fails to produce satisfactory crops, and the use of phosphates is resorted to.

Now the phosphorous which these soils contained was not in a form soluble in water, nor was it in the form of reverted or dicalcium phosphates, but was an insoluble phosphate of lime, magnesia, iron or alumina. Though termed insoluble, yet this phosphoric acid was available to crops, through the chemical changes made possible by the presence of organic matter and the compounds formed through its decomposition. It was the water charged with carbonic, humic and other organic acids, formed by the decomposition of vegetable matter, that was able to dissolve the insoluble phosphates of the virgin soils and place them either directly at the disposal of crops, or form such combinations as could be utilized thereafter.

As soon as the organic matter of the soil was consumed these favorable conditions no longer obtained, and crops could not avail of the natural properties of the soil even though there was an abundance there. Now if nature's methods are observed again, it will be noticed that wherever she is producing vegetation she has devised means for depositing some vegetable matter in the soil.

Taking all these facts into consideration would it not seem reasonable that, in order to avail properly of the phosphates contained naturally in the soil, that it would be necessary to imitate nature's methods and fill the soil with organic matter. Then again could not the phosphoric acid contained in the mineral phosphates be rendered available in the soil through the agency of organic matter if these phosphates were applied in their original chemical condition, but pulverized? If these questions can be answered in the affirmative, and the farmer can arrive at an economical and satisfactory method of providing the requisite amount of organic matter in the soil, then it will be possible to avail of the phosphates already in the soil; and thus, on some lands, make it unnecessary to purchase phosphoric acid. When recourse to purchase becomes necessary, then a cheaper form can be used and do away with paying out so much money for dissolved or acid treated phosphates, which in the end seems largely a means of accomplishing or arriving at a mechanical condition; that is, of getting the phosphates precipitated in the soil in a finely divided state and forming thin coatings over the particles of soil.

These are the ideas that called for the planning and management of the experiments outlined in the following program:

TABLE I.

Phosphoric Acid Experiments.

(Plots one-tenth of an acre each.)

Plot No.	Kind of Fertilizer and Treatment.	Quantity* Per Plot.	Quantity Per Acre.
	Crimson Clover Seeded in Corn.	*Lbs.*	*Lbs.*
1	Double Super-Phosphates (Soluble P_2O_5)	32	319
2	Dissolved Bone black (Soluble P_2O_5)	73½	735
3	Dissolved South Carolina rock (Soluble P_2O_5)	100	1000
4	Double Super-Phosphates (Reverted P_2O_5)	37	370
5	Nothing		
6	Iron Alumina Phosphate (Reverted P_2O_5)	37	370
7	Bone black (Insoluble P_2O_5)	51½	514
8	Raw bone meal (Insoluble P_2O_5	66⅔	667
9	Slag Phosphate Insoluble P_2O_5)	92	920
10	Nothing		
11	Ground South Carolina rock (Insoluble P_2O_5)	53	530
12	Florida Soft Phosphate (Insoluble P_2O_5)	56	560
	Corn-ground left bare during winter, no green crop turned under.		
13	Same as No. 8	66⅔	667
14	Same as No. 9	92	920
15	Nothing		
16	Same as No. 11	53	530
17	Same as No. 12	56	560
	Rye seeded in Corn Stubble and turned under for next crop.		
18	Same as No. 8	66⅔	667
19	Same as No. 9	92	920
20	Nothing		
21	Same as No. 11	53	530
22	Same as No. 12	56	560

*These quantities give each plot the same quantity of phosphoric acid, (150 pounds per acre, which was determined by analyzing the materials used.)

The piece of land used for these experiments lies north of the Experiment Station buildings and along the fence west of the pike. This land is a moderately stiff clay, naturally quite well drained though fairly level. The general character of the plots is quite uniform, in fact more so than most pieces of like area in this formation.

The history of the cropping of the land used for this test was, so far as known, as follows: in 1888 there was a poor stand of grass and weeds on this land, which was plowed down and seeded to wheat, which was harvested in 1889; grass 1890-91; corn 1892; fallowed 1893, and in wheat 1894—clover and timothy seeded in wheat and gave a good set.

Plots were numbered, commencing at end next Experiment Station building, toward Paint Branch.

DESCRIPTION OF PHOSPHATES USED IN THE EXPERIMENTS.

A detailed description of all the materials mentioned in Table 13 can be found in Bulletin No. 6 of this Station, so that a description of only those used in the test outlined in Table 1 will be given here. These will be described in the order of the plot numbers.

The materials used were selected so as to give all the forms of phosphoric acid found in fertilizers and to have them furnished by the chief sources of phosphoric acid on the market at the time the experiment was inaugurated.

PLOT NO. I.—DOUBLE SUPERPHOSPHATE.

This, as its name indicates, is a concentrated form of soluble phosphoric acid. It is made by dissolving mineral phosphates in phosphoric acid instead of sulphuric acid. The process of manufacture consists of treating a low grade of phosphate rock, or those too poor in phosphoric acid to make a high grade or standard superphosphate, with an excess of dilute sulphuric acid. This sets free the phosphoric acid, which, together with the excess of sulphuric acid, is removed and separated from the insoluble materials by filtration and washing. The acid solutions thus obtained are concentrated and then used for dissolving the better class of phosphate rock. Because the acids used for dissolving the phosphates contain phosphoric acid, the product yielded contains more than double the amount of phosphoric acid in the ordinary product.

Double superphosphate is manufactured, to some extent, in this country, but mostly in Europe. Its use in this country is not as great now as it was a few years ago. This was selected as one of the sources of phosphoric acid, as it contains a minimum of impurities and a maximum of phosphoric acid in the soluble form.

DISSOLVED BONE-BLACK (PLOT 2) AND BONE-BLACK (PLOT 7.)

When broken bones are placed in a retort or iron cylinder, the air being excluded, and then strongly heated, gas, water, oily matters and other products are driven off, while black-bone charcoal is left. This product, also known as bone-black and animal charcoal, is used extensively in sugar refineries for taking the coloring matter out of raw sugars. From time to time portions of the bone charcoal cease to be effective in clarifying and the spent black is then sold by the refineries for fertilizing purposes. All the phosphoric acid originally in the bones is retained, but the presence of carbon prevents the phosphate from decomposing. It is as "dissolved bone-black" that this article is generally found on the market. Dissolved bone-black contains a large proportion of soluble phosphoric acid and a very small amount in the insoluble form. Dissolved bone-black was applied on Plot No. 2, and the untreated bone-black on Plot No. 7.

DISSOLVED S. C. ROCK, PLOT NO. 3.

This constitutes by far the greater bulk of the materials now used in this country for making phosphate manures. An immense trade has grown up in this class of phosphates during the last thirty years. The most common name by which this class is known is "Acid Phosphates," but it is also found on the market as Dissolved S. C. rock, Dissolved S. C. bone, and Bone Phosphate rock. While the rock which was first used for making this class of fertilizers was first found in South Carolina, yet much of it now comes from deposits in Florida and Tennessee. The dissolved phosphates of this class contain a large portion of their phosphoric acid in the available condition, but not quite as much in the soluble form as in dissolved bone-black.

PLOT NO. 4—REVERTED PHOSPHATE OF LIME.

The phosphate applied on this plot had for its base some of the same double superphosphate used on Plot No. 1, with which had been mixed, before application, sufficient lime to change the phosphoric acid from the soluble to the reverted state. This was used in the hopes of procuring some data from the crops as to the relative availability of phosphoric acid in the soluble and reverted form.

PLOT NO. 6—REVERTED PHOSPHATE OF IRON AND ALUMINA.

This plot was added so as to give an opportunity for comparing fertilizers which contained the phosphoric acid largely in combination with lime (Plot 4) with those that had it principally in combination with iron and alumina. The material applied to this plot was what is known on the market as "Keystone Concentrated Phosphate," and was being extensively manufactured and sold about the time these tests were planned, but has gone almost, if not entirely, out of the market now.

PLOT NO. 7—BONE-BLACK.

Insoluble phosphoric acid. Description given under Plot No. 2.

PLOT NO. 8—RAW BONE, GROUND BONE AND BONE MEAL.

Animal bones are composed of two distinct substances, which interpenetrate one another. There is a sort of frame-work of earthy matter, which is phosphate of lime or bone phosphate, and a fleshy filling called ossein, which is a substance containing much nitrogen. Raw bones, are, therefore, doubly valuable for manurial purposes, because they contain both phosphoric acid and nitrogen. As ordinarily collected, bones contain from 50 to 60 per cent. of phosphate of lime and from 5 to 7 per cent. of nitrogen. Fresh raw bones also contain fat, and this is not only useless as a plant food but it adds weight to the bone and makes it hard to grind; and when ground, the more fat remaining in the bone, the slower will be the decomposition in the soil. To obviate this difficulty bones are generally steamed, or carried through some process to remove fat, before they are ground for fertilizers. Steamed or dessicated bones, if not too strongly steamed, are better for fertilizer than raw bones. Some nitrogen is lost by these processes, but if carefully done, the gain exceeds the loss. Bone-meal is obtained by grinding the crude or steamed bones, and it is valuable in proportion to the degree of fineness to which it is reduced. According to its fineness, it is variously called ground-bone, bone-meal, flour-of-bone, and bone-dust. The finer it is, if used without acid, the easier it decays or dissolves in the soil and the sooner the process of nature converts the (tri-calcic) phosphate of lime to a form available for plants. Good ground bone or bone-meal should contain from 20 to 25 per cent. of phosphoric acid and from 3 to 4 per cent. of nitrogen.

The demand for bones for use in various arts and especially in refining sugar, is making this form of fertilizing material comparatively scarce in the market and correspondingly high in price. If rates advance much it will become unprofitable for farmers to use bone fertilizers for their phosphates. The same causes lead to the considerable adulteration of bone-meal that is now found. Lime, gypsum, coal ashes, ground oyster shells, crab shells, and like articles are used for this purpose as well as the less objectionable mixing of fine ground rock phosphate, all being sold under the name of bone. When bone, ground bone, or bone-meal is treated with sulphuric acid, the product is the dissolved bone of our markets, also known as acidulated bone, soluble bone and dissolved bone phosphate. This is simply an acid phosphate or superphosphate, made from bones.

PLOT NO. 9—SLAG PHOSPHATE, BASIC IRON SLAG, OR THOMAS SLAG MEAL.

To these names may be added Thomas Scoria and Odorless Phosphate, all given to a waste material or slag, which is a by-product in the preparation of steel, by what is known as the "basic process." The object of this process is the extraction of phosphorous from pig iron, by means of a basic lining of the converter invented by Jacob Reese. The product of the process is a substance containing from 15 to 20 per cent. of phosphoric acid. It is metallic in appearance but may be ground very fine forming a dark brown meal. The phosphoric acid is in combination chiefly with lime, as tetra-calcium phosphate;

it is insoluble in water, slightly soluble in ammonium citrate, and is by ordinary methods of analysis, classified largely as insoluble. Yet its condition is such that soil water, when charged with carbonic acid, will dissolve it to a considerable degree. Thomas Slag is largely used and highly valued in Germany, and is the cheapest form in which phosphoric acid can be obtained by the farmers of that country. Eminent German experimenters have lately spoken strongly in its favor. Wagner states that two pounds of this material, ground fine, (with no acid treatment), containing 18 per cent. phosphoric acid and without any other valuable plant food, costing 4½ cents, produced the first year after its use, the same increases in yield as one pound of soluble phosphoric acid from bone-meal costing 6½ cents. And in the second year the effect of the Thomas Slag was twice that of the other. These are important facts, but the place of this slag phosphate among the commercial phosphates of this country has yet to be determined.

This material gets the name by which it is best known in Europe from S. G. Thomas, of England, who claimed to be the prior inventor of the basic process of making pure steel. This claim was disputed by Jacob Reese, of Pennsylvania, and the courts of this country have confirmed the claim of Reese. The slag is now manufactured by the latter and is sold under the name of Odorless Phosphate. This is the slag very finely pulverized but not treated with acid.

PLOT NO. 11—GROUND SOUTH CAROLINA ROCK, (INSOLUBLE PHOSPHORIC ACID.)

The material applied to this plot is the natural phosphate finely ground and just in the same condition in which the manufacturers put it before treating with acid. The phosphoric acid is chiefly in the state of the tri-calcium phosphate. If this ground rock could be successfully used so as to give satisfactory crops, the cost of a pound of phosphoric acid would be reduced over one half. These mineral phosphates are chiefly obtained from immense natural deposits in North Carolina, Tennessee, Georgia, and Florida, and generally in the rivers and low lands along the coast. Bones and fossil teeth were dug up in a swamp near the Cooper river almost a hundred years ago, but a knowledge of the extent of the deposits and their economic value have been developed within forty years.

The most prominent characteristic of the native phosphate is its nodular form. Even where the deposits occur as an apparently smooth and compact layer, or in large flat cakes, it is nevertheless composed of irregular nodules, partially cemented together. Nearly all these nodules have the egg or kidney shape. The exterior is sometimes rough and indented, often honey-combed with round or irregular holes, and sometimes it is smooth and compact. The surface is occasionally shiney and coated as with enamel. Fossil shells, fish bones and teeth are not infrequently found embedded in the nodules, and other animal remains occur in the same general deposits. The nodules vary in size from the fraction of an inch to several feet in diameter, and in weight up to almost a ton. When found, as much of this deposit is, in river bottoms or under marsh-mud, the color of the material is a grey or bluish-black. The land rock is usually of a lighter color, yellowish or greyish white. The masses are easily broken and ground to a fine powder, light yellow or grey, often becoming so light as to float in the air. In this extremely fine condition, and before being treated with acid, the material is often called Floats. There is no reasonable doubt that these phosphates came from the remains of both marine and land animals, although it would be out of place to give the evidence here. A long series of geological transformations is involved, together with different eras of animal life and subsequent changes in the mineral matters themselves. From several hundred analyses of the raw or simply ground Carolina rock, the mineral has been found to contain on an average from 25 to 28 per cent. of phosphoric acid, 2.5 to 5 per cent. of carbonic acid, 0.5 to 2 per cent. sulphuric acid, 35 to 42 per cent. lime, and a little magnesia, soda, silica, iron and other elements. The finding of the fossil bones, teeth, etc., spoken of, has led to the term "South Carolina bone" being incorrectly applied to these mineral phosphates.

PLOT NO. 12—FLORIDA SOFT PHOSPHATE; (INSOLUBLE PHOSPHORIC ACID.)

Florida soft phosphate is chiefly an alumina iron phosphate which occurs in large quantities deposited in many parts of that State. It is not well adapted to treatment with acid for making soluble phosphates, as the alumina and iron make a sticky mass which is hard to dry and keep in a good mechanical condition. The Florida soft rock has been largely used as a fertilizer in its natural condition in some parts of that State on the light, sandy land, giving good results. When used in this way there has been applied at the same time heavy dressings of the native mucks from the swamps and lakes. This muck furnishes nitrogen as well as the much needed organic matter. In order to have a complete fertilizer there is also applied some German potash salt.

The Florida soft phosphate was used in this test in order to compare the lime and alumina phosphates in the insoluble forms.

TABLE II.

Analysis of Phosphates Used on Phosphoric Acid Plots.

Index No.		Total Phosphoric Acid (P_2O_5) Per Cent.
1706	Double Super-Phosphate	47.04
1707	Dissolved bone-black	20.40
1708	Dissolved South Carolina rock	15.04
108	Reverted Iron and Alumina Phosphates	43.20
1709	Bone-black	29.20
1713	Raw bone-meal	22.48
1712	Slag Phosphate	16.32
1710	Ground South Carolina rock	28.32
1711	Florida soft Phosphate	26.80

SYNOPSIS OF TESTS UNDER CONSIDERATION.

1. Testing the principal sources of soluble phosphoric acid.
2. Comparing the availability of soluble, reverted and insoluble phosphoric acid.
3. Comparing phosphate of lime and phosphate of alumina and iron in the reverted forms.
4. Comparing the principal sources of insoluble phosphates, both in the lime, alumina and iron compounds.
5. Comparing the tri-calcium and tetra-calcium phosphates.
6. Testing the effect which green manures and the accumulated vegetable matter therefrom have, in aiding the availability of the insoluble phosphate.
7. Comparing a leguminous and a graminacious crop for the purpose of rendering insoluble phosphate available.

YIELDS OF PLOTS.

The treatment of the plots from time to time was uniform except as to the kind of phosphate applied and the use of the green manures. The details as to the yields of the crops from the various plots for the twelve years of the test are given in the following tables: 3, 4, 5, 6, and 7.

TABLE III.

Showing Yields of Corn (grain) from Phosphoric Acid Plots.

(Yields in bushels per acre.)

Plot No.	Kind of Fertilizer and Treatment.	1895	1896	1897	1902	1903	1906	Total 6 Crops.	Average of 6 Crops.
1	Soluble Phos. Acid from Double Super-Phosphate.	46.0	40.3	57.9	45.7	17.6	39.9	247.4	41.2
2	Soluble Phos. Acid from dis. bone black.	38.7	37.4	51.1	46.4	21.8	46.1	241.5	40.3
3	Soluble Phos. Acid from dis. rock..	39.0	35.8	43.6	43.6	16.2	44.6	222.8	37.1
4	Reverted Phosphate of lime.......	35.8	37.0	47.7	46.4	29.3	45.8	242.0	40.3
5	Nothing........................	42.6	42.0	57.3	42.4	33.9	43.8	262.0	43.7
6	Reverted Phosphate of iron and alumina.	45.4	43.2	64.9	50.0	18.0	42.7	264.2	44.0
7	Insoluble Phosphate, bone black...	36.9	41.6	58.1	43.2	17.8	34.1	231.7	38.6
8	Insoluble Phosphate, raw bone....	37.8	43.0	61.9	45.4	12.4	23.6	224.1	37.4
9	Tetra-Phosphate, Slag Phosphate..	38.4	42.1	58.4	39.1	7.2	26.0	211.2	35.2
10	Nothing........................	39.4	38.6	49.4	38.4	24.3	36.3	226.4	37.7
11	Insoluble Phosphate, S. C. rock...	42.4	44.8	60.7	38.3	9.3	37.7	233.2	38.9
12	Insoluble Phosphate, Florida soft rock.	44.0	46.3	63.1	46.4	35.9	44.7	280.4	46.7
13	Same as Plot 8..................	49.4	49.1	58.4	42.4	16.0	20.9	236.2	39.4
14	Same as Plot 9..................	43.4	44.4	46.6	41.6	16.0	26.7	218.7	36.5
15	Nothing........................	41.4	44.1	41.1	34.3	38.8	43.3	243.0	40.5
16	Same as Plot 11.................	47.7	45.0	40.4	41.4	32.5	39.7	246.7	41.1
17	Same as Plot 12..................	48.2	42.4	34.4	42.5	39.6	36.8	243.9	40.7
18	Same as Plot 8..................	47.1	40.4	42.7	51.4	36.0	33.6	251.2	41.9
19	Same as Plot 9..................	49.3	45.3	44.6	51.3	44.7	39.0	274.2	45.7
20	Nothing...	50.0	43.0	37.0	35.7	44.1	41.6	251.4	41.9
21	Same as Plot 11.................	45.5	41.7	30.1	47.9	29.0	41.1	235.3	39.2
22	Same as Plot 12..................	47.9	33.4	36.4	51.1	30.7	42.0	241.5	40.2

TABLE IV.

Showing Yields of Corn Fodder from Phosphoric Acid Plots.

(Yields in pounds per acre.)

Plot No.	Kind of Fertilizer and Treatment.	1895	1896	1897	1902	1903*	1906	Total 5 Crops.	Average of 5 Crops.
1	Soluble Phos. Acid, Double Super-Phosphate.	2860	2100	3020	2600	750	2000	12580	2516
2	Soluble Phos. Acid, dis. bone black.	2700	2200	2930	2600	785	2300	12730	2546
3	Soluble Phos. Acid, dis. rock.....	2400	2340	2810	2650	*	2050	12250	2450
4	Reverted Phosphate of lime......	2420	2060	2920	2650	*	2150	12200	2400
5	Nothing........................	2580	2200	3190	2150	*	2100	12220	2440
6	Reverted Phosphate of iron and alumina.	2940	2400	3330	2950	*	2200	13820	2764
7	Insoluble Phosphate, bone black..	2340	2160	3070	2550	*	1700	11220	2244
8	Insoluble Phosphate, raw bone meal.	2100	2340	3320	2750	*	1200	11710	2342
9	Tetra-Phosphate, Slag Phosphate.	2100	2320	2670	2450	500	1300	10840	2168
10	Nothing........................	1980	2060	2460	2300	1050	1800	10600	2120
11	Insoluble Phosphate, S. C. rock..	2260	2360	3060	2250	800	1800	11730	2346
12	Insoluble Phosphate, Florida soft rock.	2180	2580	3190	2770	1750	2000	12720	2544
13	Same as Plot 8..................	2760	2680	3160	3300	1300	1500	13400	2680
14	Same as Plot 9..................	2120	2500	3130	3200	950	1400	12350	2470
15	Nothing........................	2460	2360	2980	2650	2150	2050	12500	2500
16	Same as Plot 11.................	2620	2420	2880	3120	1750	2200	13240	2648
17	Same as Plot 12.................	2700	2140	3020	3330	2350	1800	12990	2598
18	Same as Plot 8..................	2520	2180	2660	3150	1500	1850	12360	2472
19	Same as Plot 9..................	2800	2320	2980	3350	1700	2200	13650	2730
20	Nothing..	2900	1900	2480	2300	2340	2400	11980	2396
21	Same as Plot 11.................	2460	1900	2820	2750	1850	2450	12380	2476
22	Same as Plot 12.................	2760	1200	2660	3400	1800	2350	12370	2475

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*Corn fodder in 1903 from same plots was used on hallow'een for building a fence across the road and made it impossible to separate the plots for weighing. This year's records are omitted from totals and averages.

TABLE V.

Showing Yield of Wheat from Phosphoric Acid Plots.

(Yield of Grain in bushels and Straw in pounds per acre.)

Plot No.	Kind of Phosphate and Treatment.	Grain.			Straw.		Totals.		
		1889 bu.	1904 bu.	Average bu.	1899 lbs.	1904 lbs.	Grain bu.	Straw lbs.	Grain and Straw lbs.
1	Soluble Phosphoric Acid, Double Super-Phosphate.	36.0	12.2	24.1	4140	1070	48.2	5210	8102
2	Soluble Phosphoric Acid, dissolved bone black.	37.1	12.0	24.6	4375	775	49.1	5150	8096
3	Soluble Phosphoric Acid, dissolved rock.	37 0	12.3	24.6	2930	760	49.3	3690	6648
4	Reverted Phosphate of lime.....	31.6	12.8	22.2	3550	1030	44.4	4580	7244
5	Nothing........................	22.0	5.2	13.6	2580	440	27.2	3020	4652
6	Reverted Phosphate of iron and alumina.	34.6	12.2	23.4	3170	1070	46.8	4240	7048
7	Insoluble Phosphate, bone black.	25.6	9.3	17.5	3415	590	34.9	4005	6100
8	Insoluble Phosphate, raw bone meal.	34.5	11.8	23.2	4100	1090	46.3	5190	7968
9	Tetra-Phosphate, Slag Phosphate.	34.8	7.2	21.0	4160	470	42.0	4630	7150
10	Nothing........................	20.7	1.5	11.1	2300	310	22.2	2610	3942
11	Insoluble Phosphate, South Carolina rock.	29.8	8.0	18.9	3710	720	37.8	4430	6698
12	Insoluble Phosphate, Florida soft rock.	30.8	6.3	18.6	3800	620	37.1	4420	6646
13	Same as Plot 8.................	35.5	10.2	22.9	3720	590	45.7	4310	7052
14	Same as Plot 9.................	37.6	6.2	21.9	4395	730	43.8	5125	7753
15	Nothing........................	22.0	3.3	12.7	2180	200	25.3	2380	3898
16	Same as Plot 11................	32.8	8.5	20.6	3530	890	41.3	4420	6898
17	Same as Plot 12................	29.1	6.3	17.7	2800	320	35.4	3120	5244
18	Same as Plot 8.................	36.0	14.8	25.4	3890	1260	50.8	5150	8198
19	Same as Plot 9.................	36.1	14.6	25.4	4030	1125	50.7	5155	8197
20	Nothing........................	22.6	2.3	12.5	3345	410	24.9	3755	5249
21	Same as Plot 11................	31.9	9.7	20.8	3285	720	41.6	4005	6501
22	Same as Plot 12................	30 1	16.5	23.3	2800	990	46.6	3790	6586

TABLE VI.

Showing Yield of Hay from Phosphoric Acid Plots.

(Yields in pounds per acre.)

Plot No.	Kind of Fertilizer and Treatment.	1900	1901	1905	Total Yield of 3 Crops.	Average Yield of 3 Crops.
	Corn-ground Seeded in Crimson Clover.					
1	Soluble Phosphoric Acid from double Super-phosphate.	3900	4300	2400	10600	3533
2	Soluble Phosphoric Acid from dissolved bone black.	4200	4310	2500	11010	3670
3	Soluble Phosphoric Acid from dissolved rock.	4950	4050	2400	11400	3800
4	Reverted Phosphate of lime...........	4250	4650	3400	12300	4100
5	Nothing.............................	4150	3450	1500	9100	3033
6	Reverted Phosphate of iron and alumina.	4800	6450	2900	14150	4717
7	Insoluble Phosphate of lime, bone black.	4000	4350	2700	11050	3683
8	Insoluble Phosphate of lime, raw bone meal.	4500	3800	2700	11000	3666
9	Tetra-phosphate, slag phosphate.......	2450	3800	2150	8400	2800
10	Nothing.............................	4000	3600	900	8500	2833
11	Insoluble Phosphate of lime, South Carolina rock.	4400	3950	2050	10400	3466
12	Insoluble Phosphate of iron and alumina, Florida soft rock.	4750	4600	2300	11650	3883
	Corn-ground bare during winter.					
13	Same as Plot 8........................	2800	4000	2500	9300	3100
14	Same as Plot 9........................	4900	4250	4650	13800	4600
15	Nothing.............................	3200	3450	550	7200	2400
16	Same as Plot 11.......................	3700	5050	3200	11950	3983
17	Same as Plot 12.......................	3950	4750	2650	11350	3783
	Corn-ground seed in rye					
18	Same as Plot 8........................	4300	4800	3850	12950	4317
19	Same as Plot 9........................	3300	5500	4100	12900	4300
20	Nothing.............................	4000	4750	1450	10200	3400
21	Same as Plot 11.......................	4550	4600	3650	12800	4266
22	Same as Plot 12.......................	3450	4200	3330	10980	3660

TABLE VII.

Showing Summary of Yields with Different Forms and Sources of Phosphoric Acid.

(Yields in bushels and pounds per acre.)

	Average of 6 Crops of Corn		Average of 2 Crops of Wheat		Average of 3 Crops of Hay	Total Average Yield of 11 Crops. Lbs.
	Grain bu.	Fodder lbs.	Grain bu.	Straw lbs.		
Average of 4 nothing plots (5, 10, 15, 20.)	40.9	2346	12.5	1470	2916	10345
Average of 3 Soluble Phosphoric Acid plots (1, 2, 3.)	39.5	2504	24.4	2342	3668	12743
Average of 2 Reverted Phosphoric Acid plots (4, 6.)	42.1	2582	22.8	2205	4409	13511
Average of 5 Insoluble Phosphoric Acid plots, crimson clover turned under (7, 8, 9, 11, 12.)	39.4	2329	19.8	2268	3500	12043
Average of 4 Insoluble Phosphoric Acid plots, crimson clover turned under (8, 9, 11, 12.)	39.6	2350	20.4	2259	3454	12059
Average of 4 Insoluble Phosphoric Acid plots, nothing turned under (13, 14, 16, 17.)	39.4	2599	20.8	2247	3866	12718
Average of 4 Insoluble Phosphoric Acid plots, rye turned under (18, 19, 21, 22.)	41.8	2538	23.7	2263	4211	13360
Average of 12 Insoluble Phosphoric Acid plots (8, 9, 11, 12, 13, 14, 16, 17, 18, 19, 21, 22.)	40.2	2497	22.5	2256	3844	12761
Average of 3 Bone meal plots (8, 13, 18.)	39.6	2496	23.6	2442	3694	12820
Average of 3 Slag Phosphate plots (9, 14, 19.)	39.1	2440	22.6	2485	3900	12918
Average of 3 South Carolina rock plots (11, 16, 21.)	39.7	2490	20.1	2143	3905	12520
Average of 3 Florida soft phosphate plots (12, 17, 22.)	42.5	2539	19.9	1889	3775	12372
Comparison of						
Reverted Phosphate of lime, Plot 4.	40.3	2400	22.2	2290	4100	12943
Reverted Phosphate of iron and alumina, Plot 6.	44.0	2764	23.4	2120	4717	14085
Comparison of						
Bone black, Plot 7..........	38.6	2244	17.5	2002	3683	11681
Bone meal, Plot 8...........	37.4	2342	23.2	2595	3666	12013
South Carolina rock, Plot 11.	38.9	2346	18.9	2215	3466	11884

DISCUSSION OF RESULTS.

The drawing of conclusions from the results of soil experiments is always attended with more or less uncertainty, as soil and weather variations will bring about what may seem to be contradictions. There are also, often uncontrollable errors introduced through depredations of various kinds.

The quantities of phosphoric acid applied in these tests are rather more than was necessary and more than would be found economical in practice; but it was thought best in planning the experiments to have an excess present and so endeavor to make the results more pronounced than to attempt to conduct the work simply on the basis of profits. The object of the investigations was to establish principles connected with the use of phosphates rather than the limits of the soil requirements.

EFFECTS OF PHOSPHATES ON CORN.

A study of the results of the application upon the corn crop as given in Tables 3, 4, and 7, are not very pronounced in any case. They are rather puzzling in that some of the applications gave slightly lower results than the "nothing" plots, yet in all these cases the differences are small and within the limits of error in such work. The results show that as far as the corn crop is concerned that insoluble phosphates are just as valuable as the soluble phosphates and that phosphate rock was just as valuable as bone-meal. The most striking and best results were obtained from the use of reverted phosphates and the Florida soft phosphates. This result, as a whole, would seem to indicate that corn was able to utilize phosphorous that was not available to other crops. A comparison of the average yields of plots 7, 8 and 11, Table 7, would seem to indicate that the nitrogen in bone-meal was of no value to the corn.

EFFECTS OF PHOSPHATES ON WHEAT.

The results as given in Tables 5 and 7 show quite conclusively that the wheat crop needed a more available source of phosphoric acid than the soil furnished naturally. The soluble sources of phosphoric acid gave the best yields of grain. The best average yield of straw was from the plots receiving slag phosphate. Wheat seemed able to utilize phosphoric acid from all the sources and forms of phosphates tried in this test. The Florida soft phosphate seemed to be the least available source of phosphoric acid for wheat which was the opposite of that for corn. The Nitrogen in bone meal showed its influence on the yields of both wheat (grain) and straw. The results show quite conclusively that a liberal supply of phosphorous is necessary for wheat.

EFFECTS OF PHOSPHATES ON HAY.

The crops of hay in this experiment consisted of mixtures of timothy and clover seeded and treated after the custom usually practiced in this and most Eastern States.

The results in Tables 6 and 7 show that all of the applications of phosphates caused a marked increase in the yields. The hay crop seemed able to utilize all the sources and forms of phosphorous advantageously. All the forms of phosphorous gave better results than that in the soluble condition. Finely ground raw rock and slag phosphate gave much better results in hay than either dissolved rock or bone-meal. The nitrogen or ammonia in the bone-meal did not seem to have any particular influence on the yields. The best average yield of all the plots was from that one to which reverted phosphate of iron and alumina was applied. The results correspond with that of corn.

"NOTHING" PLOTS. (PLOTS 5, 10, 15 AND 20.)

An examination of Table 7, page 126, shows that average total product from the plots receiving no phosphates, was considerable below all the others. With some crops the phosphates produced but little increase in the yield, and in a few instances the "nothing" plots gave higher yields than the ones to which phosphates were applied. This is noticeably the case with corn. The yields of wheat and hay were very low and showed the evident need of phosphorous. The difference in the way the various crops responded to the applications of phosphates shows that they are very different in their feeding habits.

SOLUBLE PHOSPHATES. (PLOTS 1, 2 AND 3.)

An inspection of Tables 6 and 7 will show that the soluble phosphates produced a marked influence on the yields of wheat but not as good an average yield as the insoluble phosphates on the corn and hay crops. The failure of the soluble phosphates to produce better yields of corn was probably due to it stimulating too great a growth in the early stages and thus bringing about an unbalanced condition in the plant development. A comparison of the various sources of soluble phosphates shows but little difference in the total and average yields, yet the difference which does exist is in favor of the most concentrated forms. The dissolved phosphate rock gave better yields of wheat, grain and hay than the others but did not seem to do as well on corn and the straw of wheat. The figures for the double superphosphate, which is made from rock phosphates, and dissolved boneblack are almost exactly the same.

REVERTED PHOSPHORIC ACID. (PLOTS. 4 AND 6.)

The plots receiving the phosphates in the reverted forms gave better total yields for the eleven crops and better average yields of corn and hay, than the soluble phosphates, though not quite so large yields of wheat. These results would seem to confirm the generally accepted theory that reverted phosphoric acid has just as great an agricultural value as soluble phosphoric acid. A comparison of reverted phosphates of lime and reverted phosphates of iron and alumina, (Table 7, plots 4 and 6 respectively,) shows in every instance with every crop yields in favor of the reverted phosphates of iron and alumina.

INSOLUBLE PHOSPHATES.

(PLOTS 7, 8, 9, 11, 12, 13, 14, 16, 17, 18, 19, 21, AND 22.)

An examination of Table 7 shows that the total average yield of these plots to be slightly more than that from the soluble phosphates plots. On analyzing the average yields in this table of summaries it will be seen that the wheat responded better to the soluble than the insoluble phosphates but the corn and hay crops did better on the insoluble phosphates.

A study of the various insoluble phosphates shows that the bone-meal stood first on wheat, third on corn and last on hay; and second on total average yield. South Carolina rock stood first on hay, second on corn and third on wheat. Florida soft phosphate stood first on corn, third on hay and last on wheat. The slag phosphate stood second on hay and wheat and last on corn, yet was first on the total average yield.

A comparison of bone-black, bone-meal and finely ground S. C. rock (plots 7, 8, and 11 in Table 7) shows the bone-meal to stand first and the S. C. rock second as to total average yields; but in this comparison it must be remembered that the bone-meal also furnished some nitrogen and to this extent had an advantage over the others. If we compare the rock with the bone-black, which is really bone-meal with its nitrogen expelled, then we see that the rock produced just as good yields as the bone.

EFFECTS OF GREEN CROPS ON INSOLUBLE PHOSPHATES.

The effects of the green crops during the latter half of these experiments is just the reverse of the former part as reported in Bulletin No. 68. The results in Table 7 show in the total average yield and in the average yield of all crops decidedly in favor of the rye. This may be in part due to the fact that the rye used in former years was just beginning to break up and be available. Again, it may be due to the fact that the crimson clover did not do so well in recent years, owing to weather conditions, and consequently did not furnish as much organic matter as the rye. Again, the rye furnishing a great mass of matter which decomposed slowly probably gave a drainage to the land which was advantageous during the excessively wet seasons which prevailed the last four years of this experiment. The failure of the crimson clover to maintain its former position during the last few years can not be accounted for and will make further study of this matter very desirable.

TABLE VIII.

Relative Producing Capacity of Plots when Receiving Uniform Treatment.

(Yields in pounds per acre.)

Plot No.	WHEAT—1899.		1900	1901	Total of 3 Crops, lbs.	Average Yearly Yield, lbs.
	Grain, lbs.	Straw, lbs.	Hay, lbs.	Hay, lbs.		
1.............	1535	2800	4050	4010	12395	3099
2.............	1415	2630	3500	3150	10695	2674
3.............	1835	3565	3600	3900	12900	3225
4............	2130	4070	4500	3750	14450	3612
5.............	2120	3980	4550	4050	14700	3675
6.............	2100	4300	3450	3750	13600	3400
7.............	2190	4310	4350	4100	14950	3737
8.............	2165	4100	2500	4400	13165	3291

TABLE IX.

Yield of Plots when Fertilized with Different Sources of Phosphoric Acid.

(Yield in pounds per acre.)

Plot No.	Kind of Phosphate.	CORN, 1902.		CORN, 1903.		WHEAT, 1904.		Hay, 1905.	CORN, 1906.		Total Yield, 5 Crops.	Average Yield.
		Grain.	Fodder.	Grain.	Fodder.	Grain.	Straw.		Grain.	Fodder.		
1.	South Carolina rock....	3500	3000	2410	1550	350	400	1600	3485	3000	19235	2137
2.	Dissolved South Carolina rock.	3190	3000	2185	1450	660	740	2450	2960	2500	19135	2126
3.	Dissolved South Carolina rock and lime.	3800	3050	2690	1600	415	485	3000	2485	2000	19535	2171
4.	Nothing..............	3670	3050	3570	2300	245	555	1950	3000	2250	20590	2288
5.	Tennessee rock........	4050	3000	3910	2500	550	600	3200	3660	2650	24120	2680
6.	Florida soft rock.......	3390	3300	4355	2850	665	1335	3450	3920	2500	25765	2863
7.	Virginia rock..........	3250	2300	4875	3250	600	900	4500	3800	2900	26385	2932
8.	Precipitated Phosphate.	3300	2800	4195	2200	840	1310	4200	3240	2400	24485	2721

TABLE X.

Showing the Relative Yields and Influence of Different Sources of Phosphoric Acid on Scale of 100.

(Results expressed in per cents.)

Plot No.	Kind of Phosphate.	Rate of Yield Before Experiment.	Rate of Yield During Experiment.	Difference.	Relative Increase.
1.	South Carolina rock	83	73	—10	10
2.	Dissolved South Carolina rock	72	72	00	20
3.	Dissolved South Carolina rock and lime.*	86	74	—12	8
4.	Nothing	97	77	—20	00
5.	Tennessee rock	98	91	— 6	14
6	Florida soft rock	91	98	+ 7	27
7.	Virginia rock	100	100	00	20
8.	Precipitated rock	88	93	+ 5	25

*Lime applied at the rate of 20 bushels per acre.

EXPERIMENT NO. 2—DISCUSSION OF RESULTS (TABLES VIII, IX AND X.)

In order to test some sources of phosphoric acid not provided for in the experiment started in 1895, eight more plots of one-tenth acre each were laid out and fertilized according to the schedule given in Tables 9 and 10. The phosphates were applied so as to furnish each plot the same quantity (150 lbs. per acre) of phosphoric acid P_2O_5). These plots had been cultivated in a uniform manner for several years before starting the experiment so as to know something of their relative producing capacity. The results of these yields are given in Table 8. From which it is seen that there was considerable variation. The yields for the five years of the experiment are given in Table 9. The weather conditions during the period of the test were not so favorable as during the previous period; consequently the average yields were lower than during the preliminary period. Compare results in Tables 8 and 9. In order to have these figures in a shape for comparison the acreage yields in Tables 8 and 9 were reduced to percentage, or scale of 100 basis. On examination it was found that plot 7 gave the highest average yields in both Tables 8 and 9, consequently it was decided to call that yield 100 in each case and determine the relative yields of the other plots upon that basis. The results on this basis of determination are given in Table 10. An examination of the column headed "difference" in Table 10 shows considerable variation in the comparative relative yields. An examination shows that the "nothing" plot had the greatest decrease in yield. Assuming that had it not been for the influence of the phosphate applied the other plots would have shown the same rate of decrease, consequently in reality the phosphate exerted a beneficial influence or in other words produced an increase. Working on this basis, if we call the decrease on the "nothing" plot 4, normal or zero, then express the relative yields of the other plots in the same terms we have the figures (per cents) indicated in the "relative increase" column of Table 10.

From these results we see that Florida soft phosphate gave the best results which are harmonious with the results given in Table 7. The next highest natural phosphate was the Virginia phosphate; which is also largely an iron and alumina phosphate. The finely ground Tennessee and South Carolina phosphates produced about the same effect. The dissolved S. C. rock in this series gave twice as good results as the undissolved. The liming of the land each time the phosphate was applied seemed to produce a harmful effect and while this was not to be expected, yet it showed that the failure of dissolved phosphates to act in the previous experiments was not due to the acidity of the soil. The precipitated phosphates applied to plot 8 is a by-product in the manufacture of chemicals. The good result it gives, to some degree at least, might be attributed to its fine mechanical condition. No doubt its being a precipitated product that its mechanical condition and physical properties make it much easier for plants to utilize than a product which is only finely ground. The results on this plot would also substantiate the theory advanced for the mechanical results attained in the use of soluble phosphates and their precipitation in the soil. These results also suggest that the theory of the formation of the soft phosphates and the iron and alumina phosphates was by some precipitation process.

CONCLUSIONS.

In the matter of drawing conclusions it is always well to be cautious and conservative. This policy is particularly applicable to cases like the one under consideration at this time. There is no doubt that some of the results reported upon in this connection are at variance with the principles commonly taught and the practice generally followed in the matter of fertilizers. With these considerations it would be well for those persons who desire to apply these results or to use any different source or form of phosphoric acid from that which has been successfully and satisfactorily used in the past, to do so on a limited scale in order to be satisfied that the results will hold under the particular conditions which may surround each case.

The total average results as given by the figures in Table 7 show that the finely ground insoluble phosphates; that is, phosphates which have not been treated with sulphuric acid (oil of vitriol) will produce as much and in some cases more crop than that produced by the so-called dissolved or soluble phosphates. The results obtained with the insoluble phosphates has cost usually less than one-half as much as that with the soluble phosphates.

The results show decidedly that plants are able to utilize insoluble rock phosphates.

The results with slag phosphate (mostly a tetra-phosphate of lime) gave slightly greater total average yields than bone-meal or dissolved phosphates, and at much less cost. The slag phosphates seemed to be specially adapted to grass. These results would seem to substantiate the claim of some people that this phosphate should be classed as mostly available and that official methods of analysis should be so modified as to give them more equitable rating.

Bone-meal was the best form of insoluble phosphate on wheat but its accumulative and supposed lasting effects did not show on the grass.

Bone-meal had an advantage over all other phosphates in furnishing some nitrogen.

The iron and alumina phosphates proved in all cases to be valuable sources of phosphoric acid and it would seem that they deserve a higher rank as a fertilizer than that usually accorded them.

The use of an abundance of organic matter in the soil when insoluble phosphates are applied was evidently a necessity for their best effects.

SUMMARY OF PRINCIPAL RESULTS.

1. The highest total average yield was obtained with reverted phosphates.
2. Reverted phosphate or iron and alumina produced a higher yield than reverted phosphate of lime.
3. Insoluble phosphates produced a slightly higher total average yield than soluble phosphates and at about one-half the cost.
4. Slag phosphate produced better results than bone-meal and at less cost.
5. Soluble phosphates produced the best yields of wheat.
6. Florida soft phosphate produced the best yield of corn.
7. Reverted phosphates produced the best yield of hay.
8. Insoluble S. C. phosphate rock produced a higher total average yield than dissolved S. C. rock.
9. Insoluble S. C. phosphate rock produced a little higher yield than bone-black.
10. Bone-meal produced a better yield of wheat than any other source of insoluble phosphate; but all other sources produced better grass.

APPENDIX.

There is a great demand for general information on phosphates and for the benefit of those who do not have our Bulletin No. 68, and desire some more detailed information on the various forms of phosphoric acid some of the matter contained in that bulletin is given here with additions and corrections.

HISTORY OF THE USE OF PHOSPHATES.

There is no definite record as to the time when the use of phosphates first came into existence, but as far as can be judged from the early records and writings upon agricultural topics, there seems to be but little doubt that the first commercial fertilizers ever used were chiefly phosphatic in their nature, and the good results which attended their application was mainly due to phosphoric acid.

From some notes of Varro it might appear that phosphates may have been used to some extent even B. C., but it is very sure that even if such were the case, it was not until comparativly recent times that the value and need of phosphoric acid was actually recognized. Writers record that upon the first invasion of Britain by the Romans, the natives were found using phosphatic marls to obtain better crops. But the practices were the result of accident or mere observation, and were not based upon any knowledge of the relation of soils, fertilizers and plants. The same is true of the practice of the Indians of putting fish in their hills of corn, as observed by the early settlers of America.

That there were no very definite ideas in the minds of the early users of phosphates or other mineral plant foods, at least ideas which correspond with the present existing theory of the relations of plants to mineral plant foods, is evidenced by the fact that the Prussian Academy of Sciences, in the year 1800, offered a prize for an investigation to decide whether the mineral matters found in plants are taken up from the soil or whether they are produced in the plants themselves by vital power. This question was treated by Schroader, whose decision was in favor of the latter opinion.

This opinion, though probably quite generally held, did not remain long in force, for Saussure, in 1804, declared that the mineral matter of humus contributed in a certain degree to fertility, since the same minerals are found in the ashes of plants. Sir Humphrey Davy was the first to consider the mineral constituents essential for the development of plants, as is evidenced by his statements in Elements of Agricultural Chemistry, London, 1814, to the effect that: "The chemistry of the simpler manures (the manures which act in very small quantities, such as bone dust, gypsum, alkalis and various saline substances), has hitherto been exceedingly obscure. It has been generally supposed that these materials act in the vegetable economy in the same manner as condiments or stimulants in the animal economy and that they render the common food more nutritive. It seems, however, a much more probable idea that they are actually a part of the true food of plants, and that they supply the kind of matter to the vegetable fibre which is analogous to the bony matter in animals stomachs." Springel, in his Theory of Manuring, published in 1839, was the second to express an opinion to this same effect. He said:

"We can accept it as an indisputable fact that mineral matters found in plants are real nutrients for them, and that it is not their action upon humus which makes them important, since gypsum, potassium, sulphate and calcium phosphate do not at all act upon the humus."

Closely following the statements of Springel, came (in 1840) the published results of the researches of Justus von Leibig, Leibig's results laid the foundation for our present agricultural chemistry, and entitled him to the designation of the "Father of Agricultural Chemistry."

While, as has been stated, mills for grinding bones existed early in the nineteenth century in France and England, and enterprising men went so far as to dig up battlefields and unearth thousands of tons of bones for agricultural purposes, and it is even claimed that the credit for making the first superphosphate is due to Sir James Murray, which was done in 1877, yet it was made without any real knowledge of the change which took place or application of the practical value accomplished.

As a result of his researches, Leibig pointed out that by treating bones and mineral phosphates with sulphuric acid, the insoluble phosphoric acid would be changed to a soluble form, and a considerable quantity of gypsum (sulphate of lime or land plaster), would be formed at the same time. The experiments of Leibig were substantiated by those conducted by the Duke of Richmond in comparing fresh and degelatinized bone from which he came to the conclusion that bones owed their fertilizing value not to gelatins or fatty matter, but to their large percentage of phosphoric acid. These experiments were still further confirmed by the results, shortly afterwards published by Boussingault. This set all uncertainty with regard to the value of phosphoric acid at rest and established its value and necessity on a permanent foundation, marked a distinct epoch in the use of phosphates, which, from that time, has rapidly spread and been constantly increasing.

THE ROLE OF PHOSPHORIC ACID IN PLANTS.

The function which phosphoric acid performs in plants is quite varied, yet in all cases exceedingly essential. The present status of this subject has been fully set forth by Dr. Oscar Loew, in Bulletin No. 18, of the Division of Vegetable Pathology, U. S. Department of Agriculture, "On the Physiological Role of Mineral Nutrients." The principal points which it might be well to mention here are that the chlorophyll to which the green color of plants is due, can only be formed in the presence of phosphoric acid and, hence, all the essential functions which are closely related to the chlorophyll are dependent upon this element. Relatively large proportions are found in yeast cells, in seed just forming and numerous other microscopic organizations which are playing so important a part in the growth of plants. Proper embryo development of seeds seems to be dependent upon phosphates, and some observers have claimed that the total mass of protein in seeds is increased by an increased supply of phosphoric acid.

PHOSPHOROUS, PHOSPHORIC ACID OR PHOSPHATES.

Phosphorous compounds are absolutely necessary for the maturity of plants and the formation of seed for their reproduction. It has been well established that the salts of phosphoric acid, or phosphates, as they are called, are the only sources from which the phosphorous of plants can be derived. Phosphoric acid is a combination of the element Phosphorous (P) with Oxygen gas (O). In phosphates the phosphorous and oxygen unite in the proportion of two parts of the former to five of the latter forming what is commonly designated as phosphoric acid, and this union is expressed by the sign or symbol P_2O_5. Phosphorous, when uncombined with other elements, is a yellowish, waxy looking, solid substance. It is soft and can be cut as easily as ordinary bees-wax. It is very poisonous. It ignites easily and therefore has to be kept under water. When phosphorous burns it simply unites with the oxygen of the air, forming phosphoric acid P_2O_5).

Phosphoric acid usually occurs in the soil in combination with lime, magnesia, alumina and iron. These phosphates are all practically insoluble in water, that is they are dissolved by pure water so slowly and to so slight an extent that they sustain no appreciable loss in the soil by drainage water. Hence the quantity in the soil is diminished almost wholly through the agency of crops. The amount of phosphoric acid even in a fertile soil is comparatively small. A ton of good soil will contain 3 pounds; many will contain less, and some considerably more. On this basis an acre of average soil would contain to the depth of 9 inches, about 4,500 pounds of phosphoric acid. Analysis of the nothing plots showed the soil used for the experiments reported in this bulletin to have weighed about 1,812,964 lbs. per acre to the depth of six inches and to have contained 2719 lbs. phosphoric acid. A large portion of this is not available to crops. The character of the soil effects very considerably the conditions of the plant food. One of the problems that confronts the farmer is to use such methods in soil management as will convert the plant foods which the soil contains, into forms available for crops.

FORMS OF PHOSPHORIC ACID.

As has already been stated, phosphoric acid exists in soils in combination with lime, magnesia, alumina and iron, and it is in these same combinations that is found in the various sources from which phosphates are manufactured. For the manufacture of fertilizer and in agriculture, the phosphate of lime is the most highly prized.

In nature the phosphates are found in a form, termed insoluble, which means that they are practically insoluble in water.

In manufacturing fertilizer from phosphate of lime the aim has been to change it from the insoluble condition to a soluble condition which would be more available to plants. In the natural and insoluble state the phosphate exists in what is chemically known as tri-calcium phosphate, (three-lime phosphate), and in the course of manufacture this is changed chemically so that, at the end of the operation, there exists four kinds of combinations of Calcium (lime) and phosphoric acid, which are as follows:

(1) Soluble phosphate of lime, or mono-calcium phosphate.
(2) Reverted phosphate of lime, or di-calcium phosphate.
(3) Insoluble phosphate of lime, or tri-calcium phosphate.
(4) Tetra-calcium phosphate, or four-lime phosphate.

(1) SOLUBLE PHOSPHATE OF LIME.

This is properly known under several other names as "Superphosphate," "Superphosphate of lime," "Acid Phosphate," Acid Phosphate of lime," "Water soluble phosphate," "Acid calcium phosphate," "Mono-calcium phosphate," and "One lime phosphate." Phosphoric acid does not occur naturally in the soluble state.

Soluble phosphoric acid is made by treating bones or mineral phosphates with sulphuric acid (oil of vitriol). The chemical change which occurs is practically as follows: Sulphuric acid and water being applied to the materials containing insoluble phosphates (tri-calcium phosphate), the sulphuric acid combines chemically with two parts of lime and forms sulphate of lime or gypsum (Land Plaster), while the water unites with the phosphoric acid and one part of lime, forming mono-calcium or soluble phosphate of lime. The substances being mixed, it is a natural chemical action or reaction that takes place with the result stated. The total conversion of the insoluble to the soluble form, cannot be accomplished without using such an excess of sulphuric acid as would be injurious to seeds and roots of plants which would come in contact with the fertilizer, and also would make the fertilizer of such a mechanical condition as to be difficult to handle and apply. In practice, less acid is added than is necessary to wholly convert all the phosphoric acid to the soluble form, consequently more or less of all the forms of phosphoric acid are found to be present after the fertilizing materials have been treated or dissolved. Leibig, in 1840, was the first person to suggest the treatment of bones and mineral phosphates with sulphuric acid, for the purpose of rendering the phosphoric acid available for plants. This may be said to be the beginning of the use of genuine artificial fertilizers. In the course of dissolving phosphates some of the phosphoric acid is set entirely free and will be found as free phosphoric acid in freshly made goods, but this will remain so for only a comparatively short time. It will in time act on the insoluble phosphates contained in the fertilizer. The water-soluble phosphoric acid is readily distributed in the soil, and is in a form that can be immediately absorbed by roots and used by plants as food, but unfortunately the water-soluble phosphoric acid will not remain long in the soil in this condition, for, on coming in contact with the lime, magnesia, etc., in the soil, it reverts to a condition insoluble in water. In reverting this water-soluble phosphoric acid is precipitated in such a way as to form a fine powder or coat over the particles of soil, and is thus in a finely divided state and presents a considerable surface which makes it easily dissolved by the soil waters, or the acid exudations of rootlets and thus still possesses a greater availability than any other form of phosphoric acid.

(2) REVERTED PHOSPHATE OF LIME.

Reverted phosphate of lime, also spoken of as "Reverted phosphoric acid," "Reverted calcium phosphate," "Precipitated phosphate of lime," "Citrate soluble phosphate," "Neutral phosphate of lime," and "Bi-calcium phosphate," is quite insoluble in pure water, but is easily dissolved in water containing carbonic acid or salts of ammonia and in weak acids. The term reverted was originally intended to imply that this phosphoric acid had once been soluble, but for some cause, had "gone back" to a form insoluble in water. This probably does take place to a limited extent, but as a matter of fact in the course of manufacture there is not sufficient acid used to make all the phosphoric acid soluble, and some of the tri-calcium phosphate loses only one part of lime, and thus leaves some di-calcium phosphate remaining. As has been stated some phosphoric acid is set entirely free which will unite with available phosphoric acid and bring some of it to the so-called reverted form. This form of phosphoric acid is readily assimilated by plants, because the soil and solutions from the plant roots usually contain acids strong enough to dissolve it. Reverted phosphoric acid is therefore considered nearly as valuable as a plant food as the water-soluble form. Reverted phosphoric acid is often met with in small quantities in nature in connection with some insoluble phosphates, guanos, limes and other organic matter.

AVAILABLE PHOSPHORIC ACID.

In the commercial world and in stating the results of an analysis the percentage of soluble phosphoric acid and the reverted or citrate soluble phosphoric acid are added together and the sum called available phosphoric acid.

(3) INSOLUBLE PHOSPHORIC ACID.

This is known under several names, as "Insoluble calcium phosphates," "Tri-calcium phosphate," "Bone phosphate of lime," and "Normal calcium phosphate." This form is called insoluble because it does not dissolve in water or weak acids as does the soluble or reverted phosphoric acid; but requires some strong acid to cause its decomposition or solution.

Insoluble phosphoric acid is found in nature in large quantities some of the chief sources of which will be noticed later.

Insoluble phosphates are found everywhere in the soil and most of them are of but little value to the farmer because they are not easily dissolved and can therefore be utilized but slowly by plants. One of the chief points under experimentation and reported upon in this bulletin, was to test means for rendering these insoluble phosphates available to plants through the agency of crops and cultivation without the intervention or use of sulphuric acid.

(4) TETRA-CALCIUM PHOSPHATE.

Tetra-calcium phosphate, or four-lime phosphate, is a form of phosphoric acid of recent discovery, and has been found to exist in slag phosphates. It contains more lime in proportion to phosphoric acid than any other form of phosphate. While it is insoluble in water, it has been found to be more available to plants than insoluble phosphate of lime (tri-calcium phosphate).

The following table gives the chemical composition and differences of the four phosphates of lime:

TABLE XI.

Chemical Composition of the Four Phosphates of Lime.

		Calcium, Per Cent.	Phosphorous Per Cent.	Oxygen, Per Cent.	Hydrogen, Per Cent.
1.	Soluble phosphate of lime.	17.1	26.5	54.7	1.7
2.	Reverted phosphate of lime.	29.4	22.8	47.0	0.8
3	Insoluble phosphate of lime.	38.7	20.0	41.3	....
4.	Tetra-calcium phosphate.	43.7	17.0	39.3	....

Or stating it in another way:

		Phosphoric Acid, P_2O_5.	Lime, CaO.	Water, H_2O.
1.	Soluble phosphate of lime............	60.68	23.93	15.39
2.	Reverted phosphate of lime..........	52.20	41.18	6.62
3.	Insoluble phosphate of lime..........	45.81	54.19	....
4.	Tetra-calcium phosphate.............	38.79	61.21	....

TOTAL PHOSPHORIC ACID.

Total phosphoric acid is the sum of all the forms of phosphoric acid which a given fertilizer contains. In a dissolved rock, for instance the total is equal to the sum of the soluble, reverted, and insoluble phosphoric acid contained therein.

METHODS OF MANUFACTURING SOLUBLE PHOSPHATE.

The process of manufacturing soluble phosphates from bones or mineral phosphates is not very complicated, yet requires some chemical knowledge and experience, and facilities for carrying on the operation.

The raw phosphates, whether of animal or mineral origin, are quite variable in their physical condition and chemical composition, yet the phosphoric acid will be found to be combined with lime, in the proportion of one part of the former to three of the latter forming the tri-calcium phosphate.

The chief result which the manufacturer desired to arrive at is to make the tri-calcium phosphate soluble in water or in neutral ammonia citrate. To do this the chemist has worked upon the following basis: Sulphuric acid is known to be more energetic in its action at ordinary temperatures than any other acid used in industry. It, therefore, has the power of displacing all other acids from their salts, and of taking their bases to itself to form sulphates; which, for the most part, are quite staple and easily handled substances. The acids chiefly present in natural phosphates are phosphoric, carbonic, fluoric, and silicic. These, when brought in contact with dilute sulphuric acid, are all displaced, and the bases become sulphates. Chemists have determined how much sulphuric acid is required to displace each of the various acids present, and to form sulphates with the bases with which they are combined, so that, after the composition of a natural mineral phosphate has been determined, the amount of sulphuric acid of a given strength which it is necessary to use in order to bring about the desired change of a tri-calcium phosphate to the soluble and reverted forms, can be easily calculated. These amounts have been worked out for practice as expressed in the following table:

TABLE XII.*

One Part by Weight of Each Substance Below Requires. Sulphuric Acid by Same Unit of Weight.

	At 48°B.	At 50°B.	At 52°B.	At 54°B.	At 55°B.
Tri-calcium phosphate...	1.590	1.517	1.446	1.382	1.352
Iron phosphate...........	1.630	1.558	1.485	1.420	1.390
Aluminum phosphate....	2.025	1.930	1.839	1.756	1.721
Calcium carbonate.......	1.640	1.565	1.495	1.428	1.411
Calcium fluoride.........	2.060	2.010	1.916	1.830	1.794
Magnesium carbonate....	1.940	1.860	1.775	1.690	1.660

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*W. H. Wiley's "Principles and Practice of Agricultural Analysis," Vol. II., P. 155.

Example—Suppose for example a phosphate of the following composition is to be treated with sulphuric acid, viz:

Moisture and organic	4.00 per cent.
Calcium phosphate	55.00 per cent.
Calcium carbonate	3.00 per cent.
Iron and Aluminum phosphate, nearly all Alumina	6.50 per cent.
Magnesium carbonate	0.75 per cent.
Calcium fluoride	2.25 per cent.
Insoluble	28.00 per cent.

Using sulphuric acid of 50° B., the following quantities will be required for 100 kilograms.

	Kilos of acid required.
Calcium phosphate, fifty-five kilos	83.44
Calcium carbonate, three and a half kilos	5.48
Calcium fluoride, two and a quarter kilos	4.52
Aluminum and iron phosphate, six and a half kilos	12.55
Magnesium carbonate, three-quarters of a kilo	1.40
Total	107.39

The material before treatment is always finely ground so as to facilitate the chemical action. After the treatment has been completed the mass is dried and ground for use.

The materials which are chiefly used as sources of phosphoric acid in fertilizer are given in table XIII, page 144, together with their average composition. A more detailed description of those phosphates which were used in the experiments under consideration have already been given.

AGRICULTURAL AND COMMERCIAL VALUE OF PHOSPHATES.

Notwithstanding the numerous explanations that have been given in the agricultural press, in bulletins and by lecturers at farmers' institutes, etc., of the difference between the agricultural value and the commercial value of fertilizers, farmers are continually confounding the two values, and falling into the error that because one fertilizer has a higher commercial value than another it must necessarily have a higher agricultural or fertilizing value as well.

The commercial value of a fertilizer depends upon its abundance, the ease with which it is produced and the amount being used, or, in other words, upon the ever-ruling elements in the commercial world of "supply and demand."

The agricultural value depends upon the ability of the particular fertilizer or phosphate in question to improve the fertility or productive capacity of a particular soil. Hence, it will be seen that the agricultural value, within certain limits, is not directly dependent upon the commercial value (and vice versa), and is a value that changes with different soils.

To illustrate, suppose a particular class of soils contain all the phosphates necessary for crops and that the application of any more phosphates give no returns whatever in increasing yields. This would mean that for that particular piece of land phosphates had no value agriculturally, yet that would not affect the market or commercial value of the phosphate. To illustrate further, sugar has a commercial value of $100.00 per ton, while Dissolved South Carolina rock can be purchased for one-tenth that sum. From a fertilizing standpoint, it is doubtful if an application of sugar would have any effect on the yield of crops, while the phosphate might double them, and thus have double the agricultural value of the sugar. Again, clover hay, for instance, has double the fertilizing and feeding value of timothy hay, yet the commercial or market value of timothy hay is always the more.

The following is the commercial value of phosphoric acid in different phosphatic materials according to the trade valuations.

	Cents per pound.
Soluble phosphoric acid in bone fertilizers	5
Soluble phosphoric acid in rock fertilizers	3
Reverted phosphoric acid in bone fertilizers	4½
Reverted phosphoric acid in rock fertilizers	2½
Insoluble phosphoric acid in bone fertilizers	2
Insoluble phosphoric acid in rock fertilizers	1½
Total phosphoric acid in fine raw bone, tankage and fish fertilizer	3½
Total phosphoric acid in medium bone and tankage	3
Total phosphoric acid in coarse bone and tankage	2½
Total phosphoric acid in cotton-seed meal	4
Castor pomace and wood ashes	4

From these figures it will be seen that the commercial or trade value of 100 pounds of soluble phosphoric acid in a dissolved bone would be $5.00, while 100 pounds in a dissolved rock would be but $3.00. From an agricultural standpoint, in view of all the experiments which have been conducted, the value of phosphoric acid from the two sources would be exactly the same.

Again, the above valuations place a higher valuation upon the total phosphoric acid in cotton-seed meal than that from bone, whereas, when applied, probably there would be no difference so far as phosphoric acid is concerned.

From what has been said it would be plain to every farmer that he should buy phosphate, or indeed, any fertilizer with reference to the value it has to him in increasing the productive capacity of his soil and not purchase solely upon the basis of commercial valuation as represented by agents or tabulated analysis of fertilizers.

DETERMINATION OF AVAILABLE PHOSPHORIC ACID IN SOILS.

The purpose of the agricultural chemical examination of soils, from the earliest time when the science was employed in this way, was to throw some light upon the relations of the various constituents to plant growth and especially to determine the amounts of the essential constitutents which are in a condition to be used by crops, or in other words, "available." There have been numerous methods proposed for distinguishing between available and unavailable plant foods in various kinds of soils, and this problem has occupied the attention of the best minds in agricultural chemistry for many years. No one element in this study has received as much attention as the phosphoric acid.

At the present day there seems to be a general agreement that the use of weak solutions or solvents give results that more nearly correspond to the results obtained by cropping, yet there is much difference of opinion as to the proper acid or solution to use. This condition, no doubt, is due to the variations in the chemical characteristics of the soils experimented upon.

The present status of the results obtained in this research would seem to indicate that it is very improbable that a marked distinction of any kind can be drawn between "available" and "unavailable" compounds of phosphoric acid in the soil, for the reason that it is not probable that any soil contains a compound or group of compounds which can be wholly removed by plants or dissolved by an acid that is "available," before the remaining compounds are attacked. From the very nature of the changes which are taking place in soils, produced either by crops or natural agencies, there must be more or less change and re-arrangement of the elements as different ones are attacked, thus making some phosphates available that were previously unavailable, or even the reverse may take place.

It is probable that of the many methods proposed that none of them will be equally well adapted to all classes of soils owing to the selective power of certain acids for different combinations of phosphoric acid, and they will attack different types of soils with more or less vigor, but in the main the relative action of all acids on all soils will be alike.

Hall and Plymen have recently made an extensive research and review of the methods proposed for available phosphoric acid, and have reached the conclusion that one per cent. solution of citric acid gave results which are most in accord with the known history of soils. On soils well provided with carbonate of lime, there was little difference in the result obtained with the different acids tried.

With the present state of the perfection of chemical analysis of soils it will still be necessary to put much reliance upon the results obtained by the practical use of the various phosphates in connection with the growing of different crops upon a variety of soils.

TABLE XIII.

Giving the Approximate Amount of Phosphoric Acid in Fertilizing Materials.

Materials Containing Phosphoric Acid.	Phosphoric Acid (P_2O_5).				Lbs. in One Ton.	
	Soluble, Per Cent.	Reverted, Per Cent.	Insoluble, Per Cent.	Total, Per Cent.	Available Phosphoric Acid.	Total Phosphoric Acid.
Apatite	......	......	......	38.0	......	760
Bone-ash	......	......	......	35.9	......	718
Bone-black	......	......	......	28.3	......	567
Bone-black (Dissolved)	10.0	0.7	0.3	17.0	334	340
Bone-meal	0.4	6.5	15.6	22.5	138	450
Bone-meal (from glue factory)	......	6.5	22.4	28.9	130	578
Bone-meal (Dissolved)	10 0	5.0	2 5	17.5	300	350
Caribean guano	......	......	......	18.9	......	378
Cuban guano	......	......	......	17.9	......	358
Double Super-phosphate	......	......	4.0	44.0	800	880
Florida rock	......	......	......	30.0	......	600
Florida soft phosphate	......	......	......	24.0	......	480
Keystone concentrated phosphate	0 3	38.2	9.2	47.7	770	950
Mona Island phosphate	......	7.5	14.3	21.8	150	436
Navassa phosphate	......	......	......	34.3	......	686
Orchilla guano	......	......	......	26 8	......	536
Peruvian guano	4.6	3.8	4.9	13.3	168	266
South Carolina rock (ground)	......	0.3	27.7	28.0	6	560
South Carolina rock (floats)	......	0.5	27.5	28.0	10	560
South Carolina rock (Dissolved)	10.5	3.5	2.0	16.0	280	320
Slag Phosphate (American)	......	......	......	21.0	......	420
Slag Phosphate (German)	......	......	......	30.0	......	600
Tennessee Phosphate rock	......	......	......	35.0	......	700

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CONTROL OF INSECT PESTS AND DISEASES OF MARYLAND CROPS.

By J. B. S. Norton, Pathologist, and T. B. Symons, Entomologist.

ENORMOUS LOSSES FROM INSECTS AND DISEASES.

It is not possible to accurately estimate the exact losses from these causes, as crops attacked are influenced in many ways. The loss of foliage may not show direct injury to the fruit product of an apple tree until months afterward, when great reduction in producing power is apparent and referable to the previous leaf injury; but that the reduction in amount produced is very great cannot be doubted in cases where the loss is direct and can be easily measured. In the report of the State Entomologist for 1905 it is estimated that over $5,000,000 is annually lost to this State through the work of injurious insects. In the report of the State Pathologist for 1904 a very conservative estimate taken from the reports of various farmers regarding different crops shows a yearly loss to the State of over $1,000,000 from plant diseases that could have been prevented.

Few realize the enormous loss unless some disease or insect attacks with unusual severity some fruit, grain or other product; and the annual loss of from 10 to 20 per cent. of the crops through disease of foliage, stem, etc., is scarcely noticed, or taken as the usual condition. What business man could hope to succeed and neglect such a constant waste.

CAN THE LOSS BE PREVENTED?

The control of insects and plant diseases by scientific methods is comparatively new and some of the most important problems connected therewith are yet unsolved and afford serious work for many investigators. But the last quarter-century has seen rapid development of many certain and profitable methods of controlling these pests. It can be said, then, that the greater part of the loss mentioned above can be prevented and with profit. The experience of many growers who are successfully spraying and making money by it, and those who are following new methods of growing crops to overcome the loss from disease and insects, will give affirmation to this statement. There is no excuse for the loss in wealth to the State through neglect to apply the known means of saving it. It is the purpose of this bulletin to discuss some of the means by which this can be done, and the reader will find the information arranged under suitable headings in the following pages, so that he may find what is the trouble with any particular crop and how to treat it most economically to prevent loss. The principal fungicides and insecticides and the best instruments for applying them are given, with the methods of use.

HOW CROPS ARE INJURED.

A healthy apple tree, corn stalk, potato plant, or rose bush may be regarded from the standpoint of the grower as a machine for the production of the desired apples, corn, potatoes or roses. The machine is fed with air, water and various mineral substances from the soil, and these are manufactured by it into the desired fruit, grain, vegetable or flower crop. When anything happens so that the machine does not produce as much as it should, we say it is diseased. Something may be wrong with its surroundings, so that the plant cannot get the necessary supplies to keep its own body in working condition and produce the materials desired by the farmer. The soil may lack the necessary materials, it may be so dry that they cannot be taken up, or so wet that the roots die for the lack of oxygen—actually suffocate—or salt or other substances that prevent the taking up of water may be in the soil, or the temperature may be so low or so high that proper growth cannot take place, or plant tissues or organs may be actually killed by the low temperature. The investigation of how to regulate such conditions affecting the health of plants has usually fallen to the student of agriculture.

One of the greatest causes of injuries to plants (or of diseases) is the influence exerted upon them by living things, which carry on their existence by destroying our crops or taking from their substance. These parasites may belong either to the animal or vegetable kingdom. By far the greater injury from animals is done by the insects. The most of the injury done to crops by vegetable organisms, aside from weeds which grow among them, is done by parasitic fungi and bacteria.

HOW INSECTS INJURE CROPS.

It would not be practicable to enumerate here the great variety of ways in which insects do their injury to the many crops and products, for the tediousness of relating in detail, as far as we know, the many peculiar instincts and habits of these little six-footed animals would be wearisome to the novice. Only the general principles of their attacks need be discussed. It is obligatory on the part of the observer or farmer to first make a careful examination of the manner in which the injury is being done, whether by an insect or other animal or fungus disease, for, without careful scrutiny one often makes a wrong diagnosis. After being sure of our ground, so to speak, in this determination, we must then decide how the injury was accomplished before we can intelligently employ any of our common insecticides. The majority of our insects which injure crops or products may be divided into two classes. First, those insects that eat or chew the foliage or other parts of the plant, and, second, those that suck the juices from different parts of the plant. To a third class may belong those insects that do injury by mechanical means, or by both the above mentioned ways, either biting or sucking.

The mouth-parts of insects belonging to the first class are usually fitted with strong side jaws or mandibles, accompanied by a pair of lesser jaws or maxillae, aided by palpae, and with upper and lower lips, to assist them in taking hold and biting and chewing their food plant or plants which they do only to sustain life and multiply. Such an insect with mouth-parts is shown in Figure 1.

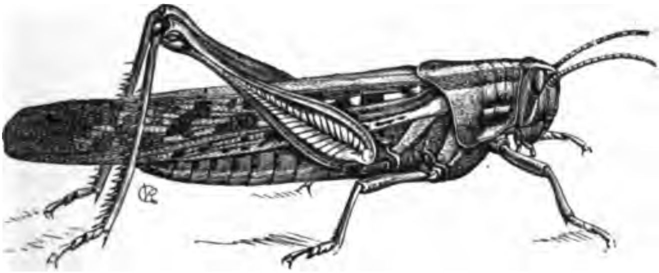

Fig. 1—Insect with biting mouth-parts.

Those insects which belong to the second class have a totally different form of mouth-parts. Here we have, instead of the jaws, lips, etc., a more or less extended beak formed usually of different parts,

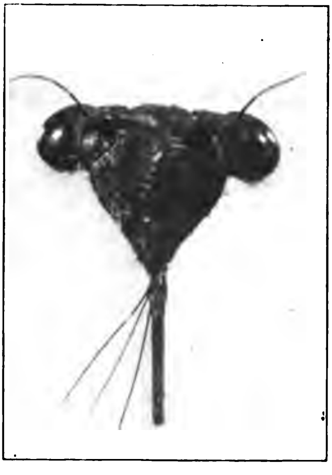

Fig. 2—Head of insect with sucking mouth-parts.

forming a tube and terminating in setae or pointed lancelets, which enable the insect to pierce the external tissues of plants in order to secure the juices from which it derives its nourishment. Figure 2 shows a typical form of sucking or haustellate mouth-parts.

To the third class belong those insects which are fortunate in having their mouth-parts formed for either biting or sucking, giving them greater advantage in securing food. A very few of our common pests, however, can be placed in this class, it being only necessary to mention it here as variations in the anatomy of the mouth-parts of these little animals. Aside from the insects that injure the farmers' crops there are many other animals, not insects, which are usually placed by the novice in the same category, and, accordingly, are sent to the entomologist to consider. Of these may be mentioned the mites, spiders, ticks, etc. It may be stated here that the remedies employed for a given type of insects will equally apply in combating other animals that do similar injury.

HOW TO COMBAT INJURIOUS INSECTS.

The fundamental facts of insect control are: First, to be able to distinguish the manner in which the pest does its injury; second, to be thoroughly familiar with its life history; and, third, to apply the remedies, if such are known, in a thorough manner.

In general, one of three methods is employed in combating any common pest. First, the application of an arsenical, or stomach poison, for those insects which do their injury by eating the foliage and other parts of plants; second, treating with a contact insecticide those insects that suck the juices of plants; and, third, the employment of either mechanical means or cultural methods for those insects that cannot be attacked in a practical manner by the preceding methods.

There are various means of applying the different insecticides.

Sprays.—The majority of stomach poisons and many of the contact insecticides are applied in the form of a fine spray on the foliage or other parts of plants. It consists of diluting the insecticide to the proper strength by water and applying by means of a spray pump. The time of application varies with the insects.

Dusting.—At times both a stomach poison as well as a contact insecticide can be applied in the form of a dust spray. It consists of dusting the insecticide onto the plants by the use of a powder gun or by other means. In applying an arsenical in this manner it is generally diluted by either land plaster, or flour, or some similar material, which can be easily dusted on the plants. Many experiments have been conducted recently with a view of testing the superiority of this method over liquid spraying, but results do not justify a recommendation in its favor. In mountainous districts, where the transporting of the spray pump and the liquid spray, which is much heavier than the dust material, is rather difficult, this method has its advantages.

Gases.—While the employment of gas in controlling insect pests is a form of contact insecticide, it is usually considered under a separate head, for its application is quite different from the usual manner of applying insecticides. Many pests can be reached by this means when it is impossible to employ other treatment effectively. A tight enclosure and an accurate estimate of the chemicals to be used is necessary in fumigating any material or place to destroy insect pests.

Mechanical Means.—There are many insects which cannot be controlled by the application of insecticides. In some cases it is practical to employ some form of mechanical means. This is accomplished by means of the hand and different mechanical devices. Illustrations of the method are worming peach trees to destroy the larvæ of the peach-tree borer, and jarring plum, or other fruit trees, in the spring to catch the adult plum curculio.

Trap Crops.—Some of our pests prefer one kind of plant above another, but if the preferred food is absent it satisfies itself by feeding on the food plant that is available. In order to prevent injury on the latter plant, which may be more valuable to a farmer in a given locality, he can plant the preferred food plant as a trap crop for the pest, the insect can then be effectively treated on the trap crop by means which may be prohibitive on the regular crop.

Rotation of Crops.—Too much care cannot be exercised by the farmer in a judicious rotation of crops. This is important not only from the point of insect attack, but also that of fungus injury, soil management and fertilization. Often he can avoid serious injury from any given pest the following season by a proper rotation of crops. Many insects that do serious injury to plants multiply rapidly if the crop is grown in the same soil year after year, consequently the injury steadily becomes more pronounced.

Resistant Varieties of Crops.—Not only does the selection of resistant varieties apply in controlling some plant diseases, but it should be employed in combatting insects. Many instances can be cited where an insect will at times totally destroy a certain variety of plant, while close at hand another variety of the same plant seems to resist attacks of the pest. In such cases, of course, the resistant varieties should be selected for planting.

Beneficial Insects.—Too much credit cannot be given to the beneficial insects for their activity in keeping many of our dreaded pests in check. As a class the *lady-birds* are the largest, but there are many other forms with predaceous and parasitic habits that aid to an untold amount in checking insects. It is necessary that the farmer familiarize himself with many of the beneficial insects, for without this we shall often be exposed to needless alarm and expense, perhaps, in fighting by artificial remedies an insect already in process of rapid extinction by natural causes, even giving up in despair just at the time when the natural checks upon its career are about to lend their powerful aid to its suppression. We may also, for the lack of this knowledge destroy some of our best friends under the supposition that they are the author of the mischief, which they are really exerting themselves to prevent.

Birds.—It is seldom that a farmer or horticulturist realizes the usefulness of birds in the protection of his crops. True it is that they repress insect criminals and charge us at a certain rate for doing so by helping themselves to produce. We observe birds helping themselves to our wheat or fruit and are ready to destroy them for their injury before considering the very much greater loss the self-same bird has saved us by destroying injurious insects, and so, by shooting or trapping it, we are actually taking money out of our pockets. While in general this is true, yet to a greater or less extent some species are more beneficial, and likewise some more injurious than others.

Finally, in the combating of insect pests the fruit grower or farmer must determine for himself the advantages to be gained in the practice of any of the above methods. In addition to our knowledge of the relation of farm or orchard pests to what we may call the natural conditions of their life, we must know how our farming operations affect them, which of our methods of culture stimulate their increase, and which, if any, may help to keep them down, and we must learn where strictly artificial methods should be used to destroy them.

SOME IMPORTANT INSECTICIDES.

The general classes of insecticides have been discussed and the general methods of application will be given later under the title of spraying, and therefore, it is only necessary here to give the different forms of insecticides in common use and the formulae by which they are ordinarily prepared.

ARSENICALS.

This class of poisons are usually applied in the form of a spray or dusted on the plants. When adding a dry arsenical to water for spraying first mix it in a small quantity of water so as to form a paste; then dilute to the proper strength. When used dry the arsenical is usually mixed with land plaster or flour and is applied with a bellows, perforated sack or powder gun.

PARIS GREEN.

Paris Green	1 pound.
Lump Lime (freshly slaked)	2 pounds.
Water	150 gallons.

This well-known arsenical is commonly used in combating biting insects. On very sensitive foliage, like that of peach, apricot, etc., it is safer to use 200 gallons of water to a pound of poison. Applied dry, the poison should be diluted by twenty times its own weight of flour or plaster.

It is often combined with Bordeaux mixture, a fungicide, in the same proportion as above, substituting Bordeaux mixture for the lime and water.

ARSENATE OF LEAD.

Arsenate of Lead	2 to 4 pounds.
Water	50 gallons.

This arsenical is used by many in preference to Paris green, for it is the least caustic in its effect upon foliage, remains in suspension and adheres to the foliage for a longer period. To prepare arsenate of lead, dissolve in water three pounds of arsenate of soda and seven pounds of acetate of lead (sugar of lead). Double the strength stated above can be used if desired, without danger of injuring the foliage There are several brands of the manufactured product on the market, which can be used if desired.

SCHEELE'S GREEN (Green Arsenoid.)

Scheele's green (green arsenoid)	1 pound.
Lump Lime (freshly slaked)	2 pounds.
Water	150 gallons.

This arsenical is very similar to Paris green, and has an advantage over it, in that it remains in suspension in water for a much longer time. It is also cheaper in price.

LONDON PURPLE.

London Purple	1 pound.
Lump Lime (freshly slaked)	2 pounds.
Water	150 gallons.

This poison is finely divided, and remains in suspension in water longer than Paris green, and it usually sells at about two-thirds the price of that poison. It is in disfavor because of its variable composition, and the danger of its burning foliage. It is also considered somewhat less effective in killing insects than is Paris green or Scheele's green.

CONTACT INSECTICIDES.

Soap.

The ordinary soft soaps and laundry soaps have long been used for killing insects with soft bodies like plant lice. There are a great many makes of soap, and most all have some insecticidal value. In using make an emulsion with water, usually about one-half to one pound of soap to one gallon of water.

WHALE OIL SOAP.

This is a well-known brand of soap, and is very effective when applied properly. For treating plant lice or similar insects when plants are in foliage, one pound of soap to six or eight gallons of water will suffice. For scale insects, like the San Jose scale, it should be used as strong as a pound and a-half to two pounds to one gallon of water. The stronger applications can only be used in the winter or early spring, when the trees are dormant.

KEROSENE EMULSION.

This, no doubt, is the best general purpose contact insecticide. It is easy to prepare, and the materials composing it are always at hand. The emulsion can be made using the ingredients in the following proportions:

Kerosene	2 gallons.
Common Soap	½ pound.
Water	1 gallon.

Dissolve the soap in hot water, add the kerosene, and emulsify by violent churning. Dilute to the strength required. If Ta-Ka-Nap soap is used, it is not necessary to add hot water. Twelve to fifteen per cent. emulsion is strong enough for killing plant lice.

LIME-SULPHUR WASH.

This wash seems to be the most satisfactory solution for the control of the San Jose scale. It should be applied either in the fall or early spring, while the trees are dormant.

Fresh stone lime	20 pounds.
Flowers or flour of sulphur	15 pounds.
Water	50 gallons.

Boil twenty gallons of water in an iron pot or hog scalder; now add the twenty pounds of lime and fifteen pounds of sulphur, which should have been previously mixed with a little hot water to form a paste. Boil the mixture, stirring occasionally, from thirty minutes to one hour, or until the sulphur is thoroughly dissolved, and produces a clear, amber-colored solution. Then dilute by adding sufficient hot or cold water to make fifty gallons. Strain into the spray barrel and apply warm.

TOBACCO.

Old tobacco stems are often steeped in hot water, a pound of the stems to a gallon or two of water. It is used as a spray or dip against plant lice. Also burning tobacco stems in a greenhouse is helpful in destroying insect pests.

HYDROCYANIC ACID GAS.

This gas has come into use of late years as an important insecticide. Its use in fumigating nursery trees to protect against the San Jose scale has become quite general. It is made by combining the following:

Cyanide of Potassium, 98%	1 ounce.
Sulphuric acid (commercial)	2 ounces.
Water	4 ounces.

This formula will fumigate an enclosure containing one hundred cubic feet; the proper proportion for larger or smaller space can be calculated from this. Place acid in an earthen jar, then add water and cyanide. Be sure to have the room or enclosure air-tight, or nearly so. Keep everything closed for at least thirty minutes or longer. It is a very *deadly gas,* and much care should be exercised in its use.

BI-SULPHIDE OF CARBON.

This liquid is used in destroying insects in stored-grain, and the like. The liquid evaporates very readily. The gas is very deadly to animal life when confined in it for any length of time. In fumigating grain, or other similar material, use two or three pounds of the liquid to one hundred bushels of grain. Place the liquid in shallow pans above the material to be fumigated. Have the enclosure air-tight or nearly so, and fumigate from twelve to twenty-four hours. The gas is exceedingly explosive, therefore, do not allow any *light,* cigar or pipe in the building when fumigating. The gas is heavier than the air.

HOW FUNGI INJURE PLANTS.

A fungus (plural fungi or funguses) is a minute plant without green stem or leaves, and so must get its food from other plants or animals. There are many thousands of different kinds of fungi. Some of the largest are called mushrooms, some of the smaller are called molds and mildews, many live on dead plant or animal substance, and by using them for food produce what we call decay. A great many kinds are able to live on live plants and draw their nourishment from them. These are the ones that cause diseases. This they do by using up the substance needed by the larger plant and thus starving it, or by interfering with its life processes by their presence, or they may kill it by forming poisonous substances within it. The fungi do not bear seeds, but they produce under favorable conditions, multitudes of microscopic reproductive bodies called spores, which serve the purpose of seeds. They are often carried by the wind from plant to plant and being so small that they cannot be seen by the unaided eye, they may spread the disease rapidly without our knowing it.

Bacteria are exceedingly small plants which live much the same as fungi, and cause the most serious diseases of plants and animals.

HOW TO COMBAT FUNGUS DISEASES.

Very few diseases of plants caused by parasites can be cured. Some caused by fungi which live mainly on the outside of the plant and obtain nutriment from inside by means of small suckers, can be killed by the application of poisonous substances to the surface. But most parasitic fungi live inside the plant tissues or only produce their reproductive organs on the outside so that the spores can be carried away easily by wind or other agencies. No devices have yet been perfected by which medicinal substances can be disseminated through plants, as they can be in animals with a circulatory system. So except for such as were mentioned above, and some which may be healed by cutting away the diseased portions, the treatment is mainly preventative, and consists of various methods of preventing diseased plants or part of plants from infecting healthy ones, or of enabling the plant attacked to overcome the disease. Some are more applicable to one disease than another. For the proper treatment for any particular disease the list of diseases of various crops, given later, should be consulted. In any case it is much better to find out what is troubling the crop rather than to apply treatment in a haphazard way. The following are some of the general methods used:

1. When possible grow varieties resistant or immune to disease. Some resistant varieties are mentioned in the following list of diseases of crops. Plant breeders are working along this line at the present time, and disease resistant strains may be developed for most of our important crops. Farmers can do much to aid in this work by watching for resistant individual plants among diseased ones of the same kind in any crops which they may be growing and saving seed from it, or, better, calling the attention of professional plant breeders to the same.

2. Keep plants in vigorous condition by proper cultural methods A check in growth or anything which draws from their food supply often renders them liable to the attacks of parasites.

3. Select seed, cuttings or other propagating stock from healthy plants. Seeds from diseased plants may carry the parasite or may transmit a predisposition to their offspring.

4. Destroy diseased portions of plants.

5. Insects are a very common means of introducing diseases which, without them, would be barred by the unbroken epidermis of the plant. Anything coming in contact with diseased plants and then with healthy ones is liable to transmit disease.

6. Fields, where diseased crops are grown, may carry over winter the infecting material and contaminate the succeeding crop. It is better to follow a diseased crop with some other, not subject to the same disease. This is one of the benefits of rotation of crops. Some fungi may live in the soil for several years.

7. Wild plants of the same family are usually liable to the same diseases as their cultivated relatives.

8. Large fields of one crop, or a lack of diversity of crops in any region, favors the spread of diseases.

9. Wounds in trees or other plants, whether made by pruning or otherwise, favor the entrance of disease germs, and when they cannot be avoided the exposed surfaces should be protected by paint or

some substance to take the place of the broken bark or epidermis. White lead in linseed oil is a good material in general.

10. Weather and soil conditions control the growth of fungi, just as they do with other plants. Alkaline conditions that favor some fungi, as potato scab, can be corrected by proper fertilizers. The application of lime hinders the development of others as the club root of cabbage. Drainage may help in controlling some root diseases.

11. The application of fungicides to prevent the development of parasites is a very important process, and is more fully discussed in the next section.

THE MORE IMPORTANT FUNGICIDES.

A fungicide is some preparation to kill or prevent the development of fungi. Most of the fungicides here described are made of chemicals that can be purchased at drug stores or from agricultural supply houses. Fungicides are applied as gases, as liquids, or in solid form. In solid form they are usually dusted over the plants to be treated by means of a bellows or blower especially prepared for this purpose. The plants or seeds to be treated are dipped in the liquid, or it is sprayed upon them. Spraying is the principal means employed to control plant diseases. The fungicides applied protect the plants in a few cases by killing the fungus causing injury, if it is growing on the outside of the plant. But usually the parasite is inside the leaf or fruit and only produces its spores on the surface. Then the fungicide may destroy these spores before they can be carried to healthy vegetation, or it may prevent the development of spores alighting on the plant to which it has been applied.

BORDEAUX MIXTURE.

Bordeaux mixture is used more than any other substance to prevent plant diseases. It is made of copper sulphate (blue stone) dissolved in water and mixed with stone lime slaked in water. There must be enough lime to combine with all the copper sulphate so that it will not injure foliage, otherwise the proportions may vary considerably for different purposes. The formula usually used is the 5-5-50 formula:

Copper Sulphate	5 pounds.
Lime	5 pounds.
Water	50 gallons.

Dissolve the five pounds of copper sulphate by immersing in a bag hung in the top of a vessel of water for several hours, and dilute to twenty-five gallons of water, a half-barrel can be used to hold it. Slake the lime in a similar vessel and dilute to twenty-five gallons. Pour the two together through a strainer into the sprayer (see Figure

3). The bright blue liquid resulting is Bordeaux mixture. The lime should be kept stirred, as it settles quickly. The copper sulphate will act on iron and some other metals. Brass or wooden vessels should be used for it. The milk of lime and copper sulphate solution should not be mixed while hot or before diluting. They will keep indefinitely before mixed, but the Bordeaux mixture should be used the same day made.

Where several barrels of Bordeaux mixture are to be used, the use of stock solutions will save much time. These are made by dissolving fifty pounds of copper sulphate in fifty gallons of water in one barrel and slaking fifty pounds of lime and diluting it with fifty gallons of water in another barrel. Then, for making Bordeaux mixture take as many gallons as pounds of each substance desired, dilute and mix as before. When proper water supply is at hand, the stock barrels, diluting tubs, etc., can be arranged on an elevated platform so the liquid can be passed from one to the other from spigots, and then run in similar manner through hose into the sprayer thus saving much dipping, etc.

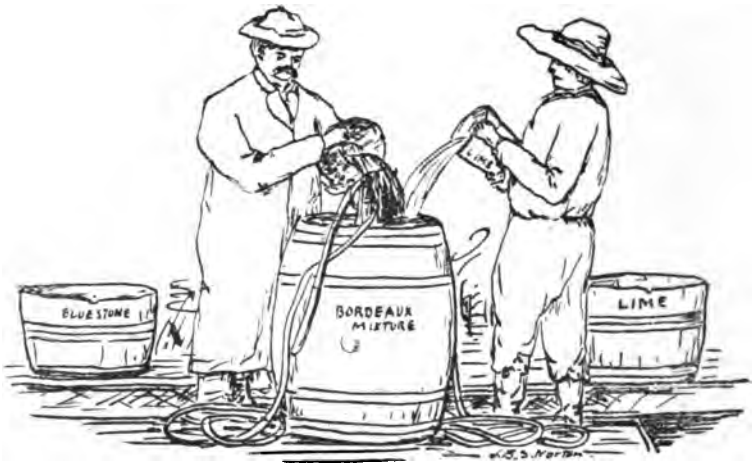

Fig. 3—Making Bordeaux mixture.

The properly prepared Bordeaux mixture should have a bright sky-blue color. If the lime is poor it may have a greenish cast, and is then liable to injure foliage. It can best be tested by dropping a little solution of yellow prussiate of potash into the mixture. If a reddish brown color results, add lime until the test repeated shows no brown color. It is usually better to add more lime than enough to combine with the copper sulphate. One-third pound of Paris green to the barrel can be added, if desired, to kill insects. The Bordeaux mixture is an excellent medium in which to apply all similar insecticides.

Peach Bordeaux mixture for use on peach and plum foliage or other plants liable to injury by the stronger mixture used for most crops, is made in a similar manner by the following formula:

Copper sulphate	3 pounds.
Lime	9 pounds.
Water	50 gallons.

One must be sure the lime is good, as with this excess of lime, the before-mentioned test would not be practicable.

In making Bordeaux mixture various other alkalies have been used instead of lime to combine with the copper sulphate, for example: caustic soda, washing soda, caustic potash, ammonia (in eau celeste), etc. There is no special advantage and some are liable to injure foliage more than the lime Bordeaux mixture and, if made of materials that alone would burn foliage, just enough to combine with the copper sulphate must be used, while with the lime an excess can be used to advantage in many cases.

Bordeaux mixture will not stick to water-repellant surfaces, such as cabbage leaves and asparagus. The addition of hard soap, dissolved in water, four pounds to the barrel, will help to overcome this difficulty.

DUST BORDEAUX MIXTURE.

The dust mixture is sometimes used for the same purposes as the liquid in regions where, on account of hills, etc., it is difficult to haul the liquid. It is not so expensive to make and handle, but is much less effective than the liquid form and must be applied much oftener. It is made as follows, according to W. M. Scott:

Dissolve four pounds of copper sulphate in four gallons of water and slake four pounds of lime in four gallons of water. When cool, pour together, allow it to settle, pour off the liquid, put into a double flour bag and squeeze out as much more water as possible. After drying for a day in the sun it is crushed, screened through an eighty mesh to the inch sieve and thoroughly mixed with sixty pounds of slaked lime dust.

COPPER SULPHATE SOLUTION.

If a very strong copper fungicide is desired for dormant plants, copper sulphate, three pounds to fifty gallons of water, may be used.

COPPER ACETATE.

Dibasic acetate of copper, six ounces to fifty gallons of water, is used where a clear fungicide is desired, as it is readily soluble in water, and Bordeaux mixture may leave stains on fruit and foliage. It is somewhat more injurious to foliage and is not so good a fungicide as Bordeaux mixture.

AMMONIACAL COPPER CARBONATE.

This is used when the stains of Bordeaux mixture are undesirable. It is not so effective as the latter and more liable to injure foliage. It is made as follows:

Copper carbonate	5 ounces.
Strong ammonia (26 degrees Beaume)	2 to 3 pints.
Water	50 gallons.

Make a thin paste of the copper carbonate with water, and after diluting the ammonia with about two gallons of water, add half of it to the carbonate, stir for several minutes, allow it to settle, pour off the solution and add more ammonia water to the undissolved portion, repeat the process until all the carbonate is dissolved, using no more ammonia than is necessary to dissolve it. Then add to the solution the remainder of the fifty gallons of water and it is ready for use.

LIME-SULPHUR WASH.

This preparation, described under insecticides, is valuable as a dormant spray for fungus diseases that can be treated at such times. When it is recommended to use Bordeaux mixture on fruit trees before the buds open this can take its place, but is not so effective and cannot be used on plants in leaf.

POTASSIUM SULPHID.

Potassium sulphid one ounce dissolved in three gallons of water is used for surface mildews. It should be used as soon as made as it deteriorates rapidly.

SULPHUR.

Sulphur is used in the form of "flowers of sulphur" or "flour of sulphur" as a fungicide. The former is usually better for applying in the dust form for mildew, asparagus rust, etc. The flour of sulphur is usually made into a paste with water, and spread on heating pipes in greenhouses, for mildew, etc. The fumes from burned sulphur are used in disinfecting empty greenhouses or other buildings, but are very destructive to live plants.

CORROSIVE SUBLIMATE.

Corrosive sublimate, one part to 1000 parts of water is used as a disinfectant. It is a deadly poison. It is used in this strength in cutting out pear blight.

This is also used to disinfect potatoes for scab, before planting; two ounces to fifteen gallons of water is used.

FORMALIN.

The commercial formalin (40%) is used one pint to fifty gallons of water for grain smut and one-half pint to fifteen gallons of water for disinfecting potatoes affected with scab. It is poisonous, but not so dangerous to handle as the corrosive sublimate. Formalin is one of the best disinfectants for all purposes.

PROPRIETARY PREPARATIONS.

Many proprietary preparations, for controlling insects and plant diseases, are on the market. Some of them are very good. But, as a rule, they cost more than those which can be made by the user as recommended in this bulletin. Any claims made for a material as a general cure-all for any kind of plant disease or insects are apt to be fraudulent. There are hundreds of different kinds of parasites with very different life histories and requiring very different treatment, according to the crop attacked.

IS THERE DANGER IN THE USE OF FUNGICIDES AND INSECTICIDES?

Some have thought the application of copper compounds and arsenical mixtures to fruits and vegetables, intended for food, would make them poisonous to man. It has been shown that one would have to eat 300 to 500 pounds per day of grapes sprayed with Bordeaux mixture to experience ill effects from the copper, and that even if all the Paris green sprayed on apples for codling moth should remain there, one would have to eat eight to ten barrels of the fruit to be injured by the arsenic.

Potatoes, treated with corrosive sublimate for scab, contain enough poison to be injurious to animals eating them.

If the chemicals used are applied too strong, or are improperly made up, injury may result to foliage of plants sprayed. *Careful attention should be given* to all the details given about preparing and using fungicides and insecticides. An effort has been made to cut out all unnecessary matter from the directions given in this bulletin, and to make it as brief and simple as possible.

Even with the best of care the leaves of some trees will be injured occasionally by sprays, but the injury will usually not compare with the good results obtained. Trees and other plants, which have a limited blooming period, should not be sprayed when in bloom.

Most of the chemicals used in protecting plants from insects and diseases are poisons, if taken internally, and should be handled and labeled as such. With reasonable care there is no danger from their use.

SPRAYING AND SPRAYING OUTFITS.

The continued increase in spraying crops for the control of insects and diseases, has created a large demand for spraying apparatus of improved types. Manufacturers of these articles have been active in perfecting their different patents to meet the demand. So that today the prospective purchaser has a variety of styles of spraying outfits from which to select.

The question is frequently asked "What is the best pump to buy?" As a matter of fact, there is no "best" pump on the market. The conditions under which spraying is done are so varied that only general recommendations can be made, and each individual will have to select that which his judgment dictates is best adapted to his conditions. A common error, is to purchase a pump of too small a capacity because it is cheaper. A smaller, cheaper pump usually means less accomplished in a day with the same labor and usually a poorer class of work. Also it is sometimes of much importance to complete the desired amount of spraying in as short a time as possible after it is begun. To do this a pump of large capacity is necessary.

While no specific laws can be laid down in purchasing outfits, yet some fundamental facts in regard to such apparatus may aid in deciding on an outfit.

BUCKET PUMPS.

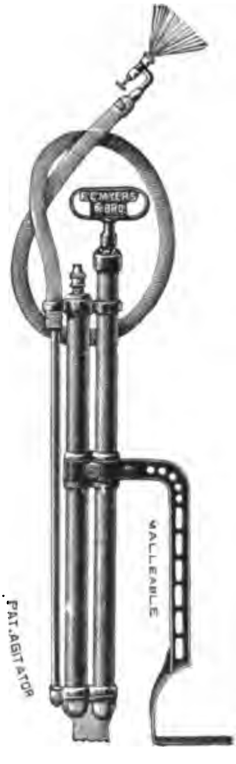

Fig. 4—A bucket pump.

Where spraying is to be done on a very small scale, that is, treating one or two trees or bushes, or other growing plants around the home, a bucket sprayer, as shown in the accompanying cut, Figure 4, will serve the purpose. They are usually made to set in a bucket, with a clamp attached to the side of the bucket and a foot piece extending to the ground, by which the foot can hold it rigid. These pumps are usually very durable, and handy for certain kinds of work.

KNAPSACK AND OTHER HAND SPRAYERS.

This pump, as shown in Figure 5, is designed for similar work as above, except on a more extended plan. Such pumps are used in spraying low-growing plants, especially if their habit of growth and surroundings will not permit the use of large apparatus. A true knapsack sprayer consists of a small tank, containing from three to five gallons of solution, in which is fitted a small pump. The whole apparatus is carried on the back, the pump being worked by the hand, through a lever which extends down in easy reach. It is sometimes

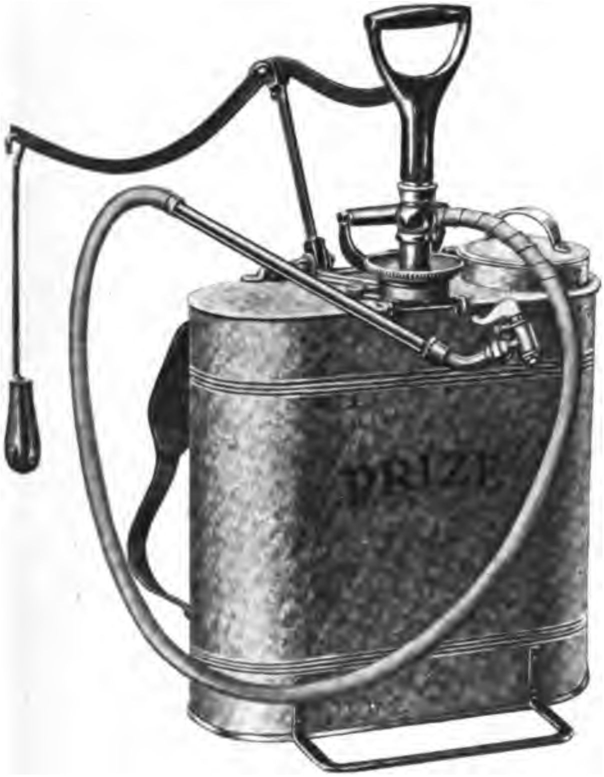

Fig. 5—A knapsack sprayer.

used by greenhouse men, who find it convenient for sprinkling, the sprayer being on the back of the operator permits him to pass along the aisles freely, using one hand to operate the pump and the other for spraying. The feature of carrying the pump on the back is not a favorable one to the sprayman, as the leaking and waste sometimes makes it very uncomfortable. We believe that this particular form of pump is fast going out of use, and is being supplemented by pumps as shown in Figure 6. This form can be used for the same purposes and is considered by many the more handy and convenient of the two. They are known as compressed air pumps. The tank holds about three to four gallons of liquid and a compressed air chamber. After filling up the tank, a sufficient amount of air can be pumped in before you start spraying, to spray out most of the liquid. They are used in spraying low-growing plants, such as cantaloupes. Many of these pumps are in use all over the State.

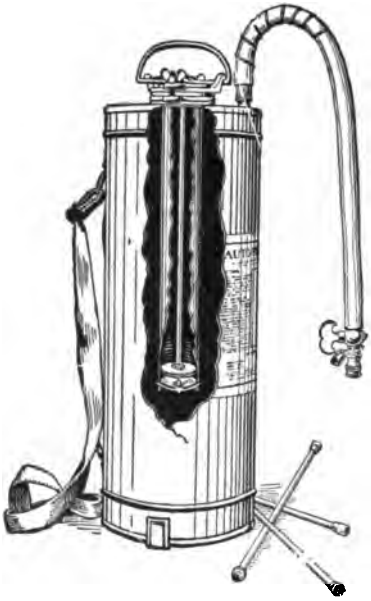

Fig. 6—Compressed air hand sprayer.

BARREL PUMPS.

There is perhaps a greater variety of this size of pump on the market than any other, due to the fact that they are the most common size used for general spraying. It would be impracticable to explain all the different types and makes in this discussion. Figures 7 and 8 illustrate the size and form of the pumps. Whatever the size selected the pump should be strong, simple in mechanism, and capable of maintaining a constant high pressure to deliver a large amount of liquid with force. It should be made of material that will not easily corrode

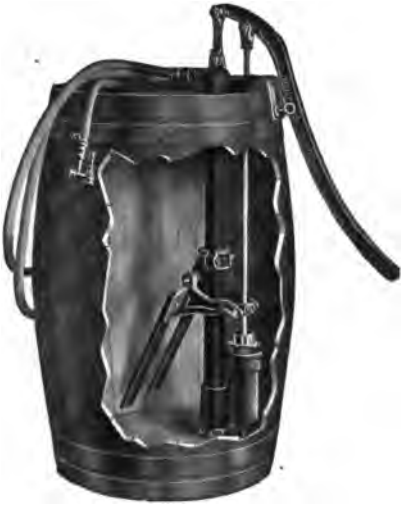

Fig. 7—A good type of barrel spray pump.

or rust from contact with the various insecticides and fungicides. Especially should the working parts be of brass and, likewise, it is

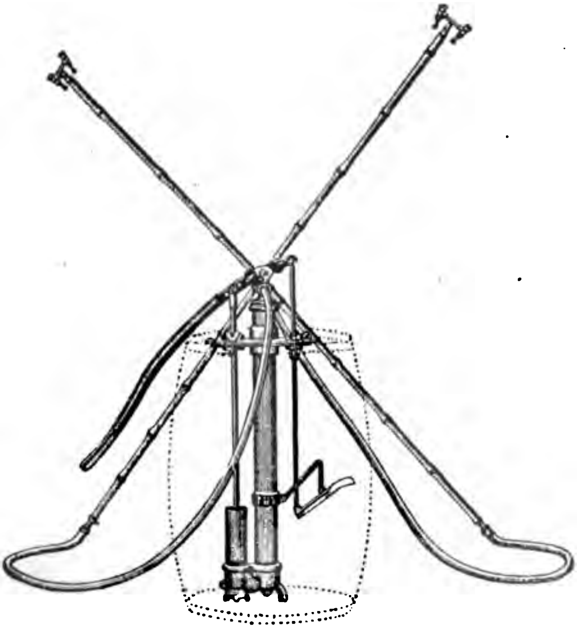

Fig. 8—Another good type of barrel sprayer.

important to have the packing in a convenient place where it can be removed without much trouble, and for this reason pumps with solid plungers are more desirable.

VALVES. The structure of the valves in a pump is a very important feature. They should be made preferably of brass and, of necessity, perfect fitting. When these parts are made of leather the pump may work for a time, but the material soon becomes stiff and hard and requires frequent replacing.

AGITATORS. An agitator is a very necessary adjunct to all classes of spray pumps, for success in spraying will sometimes depend on keeping the liquid thoroughly stirred up. While most pumps are fitted with some form of automatic agitator, it is well to look into the ability of any particular apparatus for keeping the solution well mixed.

AIR CHAMBERS. The air chamber should have sufficient capacity to insure a steady spray. It should be combined with the other parts of the pump as shown in Figures 7 and 8. The position and size of the air chamber should be carefully examined.

GENERAL STYLE. While the details of construction of the many pumps vary, these general principles should be observed: Buy the pump which is compact and simple in construction. Do not have too much of the pump above the surface of the barrel, and have it easy to get at in the barrel, or, better, easy to remove from the barrel. The clamps used by some manufacturers allowing you to transfer a pump from barrel to barrel without unscrewing bolts and avoiding other troubles is desirable. Also have all points of attachment of the hose cut with threads of standard size. The handles should be made of malleable iron as they are not then so easily broken as if made of cast iron. The illustrations cited will give the reader some idea of types of barrel pumps on the market. A good barrel pump with fixtures can be bought for from $15.00 to $20.00.

HORIZONTAL DOUBLE-ACTING PUMPS.

This class of pumps is used by the more extensive fruit growers. They are more powerful, so that four leads of hose can be attached, if desired. They, however, work very easily by hand. The pump which is double-acting is connected with the tank containing the spraying mixture by means of a section of hose which is shown in Figure 9. Such a pump can be secured for about $30.00.

POWER SPRAYERS.

The increased planting of orchard fruits during the last few years has given rise to many quite extensive orchards, which has brought about a demand for power sprayers in order to facilitate the work of spraying these large orchards in a short space of time. The labor problem in the United States has also contributed towards increasing the demand for this machinery. The question of the most economical pump or apparatus is debatable, and, no doubt, may be in favor of the barrel pump, if the labor problem does not enter into it seriously. However, it seems that the power sprayers are steadily coming in favor with the commercial orchardists.

GEARED SPRAYERS. This type of sprayer has been on the market for some time. It usually consists of a mechanical arrangement connecting the pump with the wheels of the wagon, cart or specially constructed spray wagon. When arranged on a simple barrel pump for spraying low growing crops, such as potatoes, where the wheels can be in continual motion, except at the end of rows, they have proved fairly successful; but when fitted with larger pumps to do orchard spraying, seldom can sufficient force be maintained to throw a steady spray without the machine is in motion all the time, and it is impossible to do thorough spraying under these circumstances. Manufacturers have realized this condition, and, for the past few

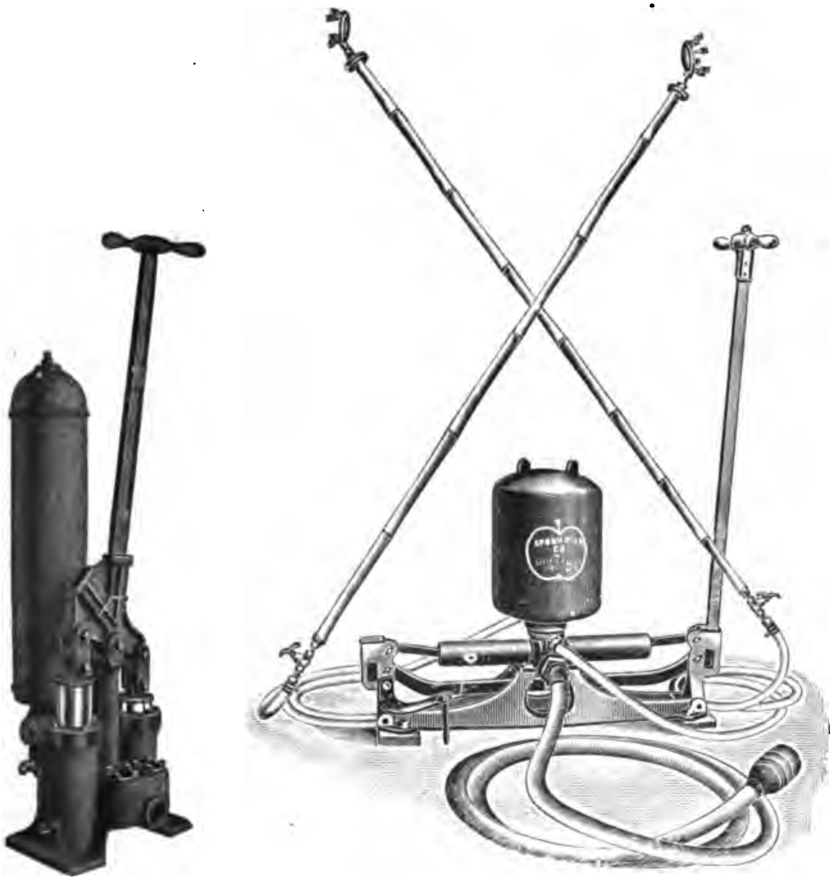

Fig. 9—Two types of double-acting spray pumps.

years have been expending their energy toward perfecting other forms of power sprayers.

STEAM AND GASOLINE OUTFITS. The majority of the power outfits on the market today employ either steam, made in a small two or three horse-power boiler, or use the gasoline engine, and, no doubt, the larger number employ the latter. The objection to the steam boiler, with the accompanying apparatus, being its weight. However, the gasoline sprayers have their drawback in trouble arising in the working of the engine, etc., necessitating delays in the operation; the objection of weight also applies to a certain extent with many gasoline rigs. Usually one and one-half to two horsepower engines are used. The continued perfecting of these engines will be of much importance in the success of such outfits. One advantage in the use of such an engine in spraying is that it can be detached from the pump and used on the farm for various other purposes. Figure 10 illustrates a gasoline outfit.

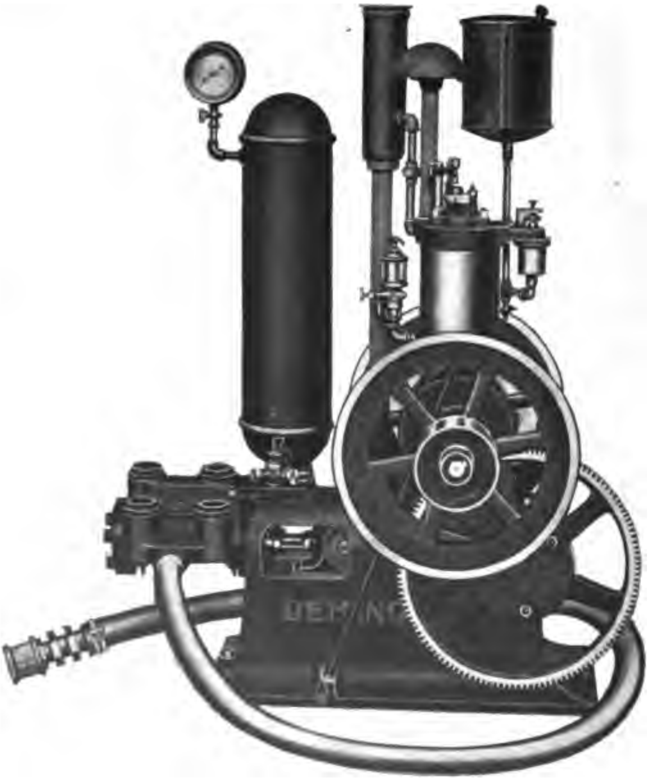

Fig. 10—Gasoline spraying engine.

GAS SPRAYERS. This form of power sprayer is of comparatively recent introduction. The machines are operated by liquified carbonic acid gas. There is no doubt that a decided step of progress is manifested in these machines, for they are very simple in construction and give apparent satisfaction in spraying, but the expense of maintaining the machine seems to be a great drawback, especially when, after being used for some time, leaks occur in the apparatus, thus wasting the carbonic acid gas, which is quite expensive. These obstacles may be overcome in the future, but, even then, the expense of the gas as compared with the gasoline used in the gasoline engine will, no doubt, prevent general adoption. To those anticipating securing a power sprayer we advise a careful study of the kinds and makes on the market. Figure 11 shows a gas sprayer.

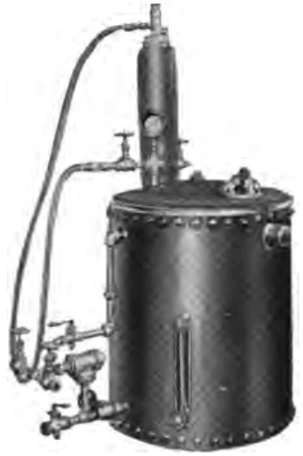

Fig. 11—A gas sprayer.

SPRAY PUMP ACCESSORIES.

HOSE. It is important in spraying to have plenty of good hose. That is to say each lead of the hose from the pump should allow the sprayman to surround the tree without moving the pump. The thoroughness of spraying often depends on this one requisite. Have each lead from 20 to 25 feet long. It is not necessary to say that the best quality of one-half inch hose should be used in this work.

EXTENSION ROD. It is generally convenient to have a hose attached to an extension rod of either iron or bamboo with brass tube. They should be from four to ten feet in length, according to the character and size of the trees to be sprayed. A blacksmith can easily make one from one-quarter to one-half inch gas pipe. A six-foot rod is used more generally. (See Figure 12.)

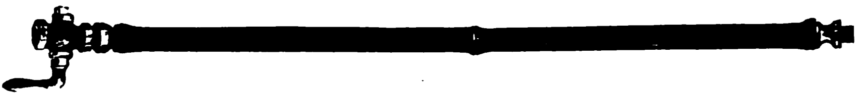

Fig. 12 Bamboo extension rod.

STOP-COCK. Be careful to have a leakless stop-cock at the end of the hose attached to the extension rod. This will avoid wasting material when moving from tree to tree and allows the liquid to be shut off from the pump when the nozzle is stopped up.

NOZZLES. In general there are two classes of nozzles, one giving a fanlike spray and the other a conical spray. Figures 13, 14 and 15 show these types respectively. The many pump manufacturers make these different nozzles and the selection is again left to the purchaser. The nozzles are often combined, that is to say, we have single or double Vermorel or two Seneca nozzles can be attached to one hose. The number used depends on the force of the pump employed.

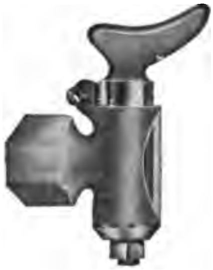

Fig. 13—Nozzle giving a fan-shaped spray.

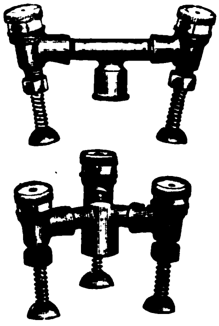

Fig. 14—Double and triple vermorel nozzles, producing conical spray.

The essentials of a nozzle are that it should throw a fine, misty spray a long distance and not be easily clogged.

STRAINER. All mixtures should be carefully strained into the spray barrel or tank to insure uninterrupted service of pump and nozzle.

The most durable, no doubt, is the brass wire strainer. It should be about 18 to 20 mesh.

ROW SPRAYERS. This is a very convenient device that can be connected with the barrel sprayer and attached to a cart or wagon and serve to spray low-growing crops in rows to great advantage. Figure 17 shows this arrangement.

TANKS. In the use of barrel pumps the barrel serves as the tank for holding the solution. In using some of the pumps on the market they will permit of taking one or two barrels of solution along in the wagon, as the pump can be easily transferred from one barrel to another. In the case of the horizontal double-acting pumps or power sprayers it is necessary to have a regular tank, the size varying according to the requirements. In case of a long haul from the orchard to the source of supply, of course, it is economical to have as large a tank as convenient to transport in the orchard. The accompanying figure, 18, shows the usual form of a tank. Generally such tanks are made to fit the bolsters of the wagon, which is the most handy way of hauling the same. In using horizontal pumps they can be fitted on top the tank; in power sprayers the power in the form of either gas or air tube or engine can be located in another convenient place on the wagon.

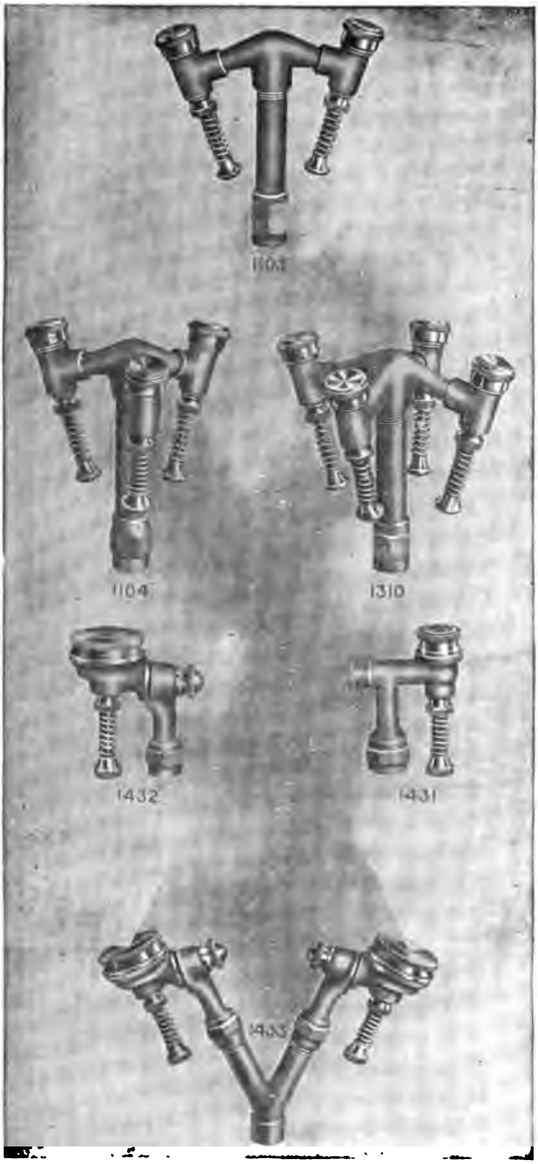

Fig. 15—Various types of nozzles.

RACKS. In the treatment of large trees, either fruit or shade, it is often very difficult to reach the terminal branches, even with the six-foot extension rods. In such cases the use of a rack built on the spray wagon, with a platform on the top, on which the spraymen can stand, will greatly facilitate the work.

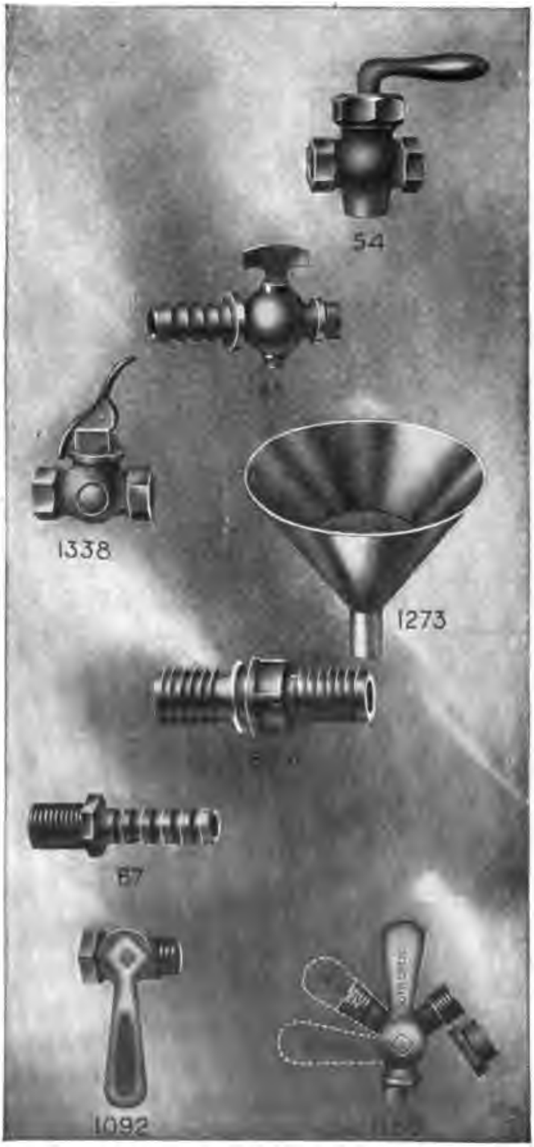

Fig. 16—Spray pump accessories.

SOME TROUBLES IN SPRAYING.

It often happens that a pump fails to work. There are many minor troubles which may occur. First, a little sediment may become lodged under one of the valves, causing it to leak. If lime is being used in the spray solution it is apt to accumulate over the strainer at the bottom of the pump. Of course, these troubles can be easily remedied by cleaning the particular parts. Repacking the pump is necessary at times, as the packing becomes worn and, causing a leak by the plunger, the force of the pump is lost.

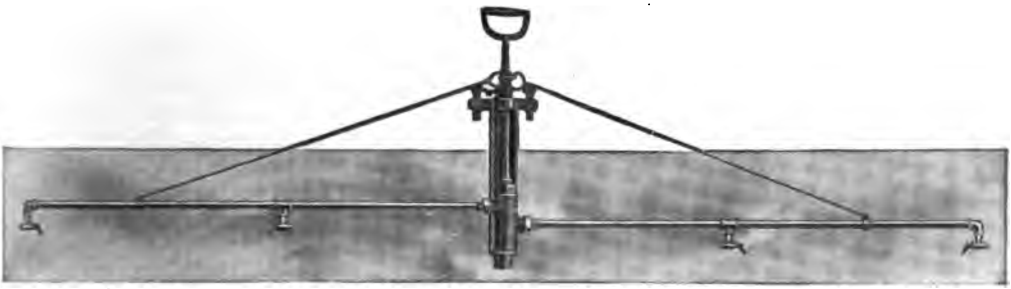

Fig. 17—Row sprayer attachment.

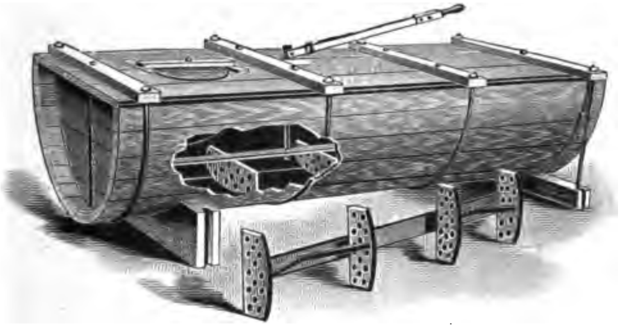

Fig. 18—Tank for carrying spraying mixtures.

CARE OF SPRAYING APPARATUS.

The life of a pump or other spraying apparatus depends largely upon the care given it both at work and at rest. During the spraying, pumps, hose, etc., should be washed out thoroughly every night after finishing the day's work, even if the pump is being used every day. When the apparatus is to stand for several days or months unused, it should be given a more thorough cleaning by washing off the corrosive mixtures and freeing the valves and other parts of all sediment, which might otherwise dry and become incrusted on the parts. If there is a long period between sprayings, it would pay to remove the pump from the tank, taking it apart and oiling all the parts to prevent rust.

Likewise, the hose should be handled with care. It should be hung up in such a manner as to allow the water to run out. The fault of using too short a hose has a decided effect upon the piece in hand. If it is somewhat short, it is often bent too much or stretched around angles or corners, causing more or less injury at times. The cleaning of the hose and nozzles is equally important to their life in preventing vexatious stoppage in the operation.

APPLICATION OF DRY MATERIALS.

At times it seems desirable to apply an insecticide or fungicide in its dry state, as in dust spraying of Bordeaux mixture or Paris green. Many styles of small machines for this purpose are on the market. The handiest of the inexpensive forms is that in which a receptacle for containing powder is so attached to a small hand bellows that the dust is thrown in any desired direction. Sometimes guano sacks are used in applying the dust to a low-growing plant by jarring the material through the small holes in the sack. Figure 19 shows a commercial powder gun.

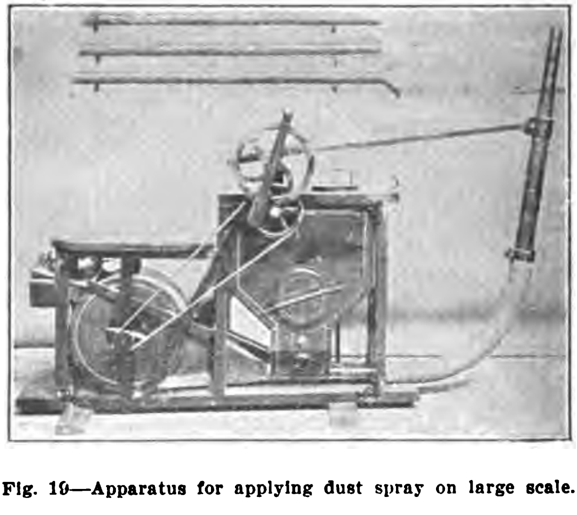

Fig. 19—Apparatus for applying dust spray on large scale.

GENERAL RULES FOR SPRAYING.

In the observance of the general rules for spraying, the first requisite is to know exactly what the spraying is intended to control or check. Ascertain the proper time of the year to make the application. Make your solution carefully, according to the formula given. Secure a good serviceable pump and necessary apparatus and commence spraying with the intention of doing a thorough job. So much of the spraying is only half done. Remember, in spraying trees, all parts must be hit. The length of the hose will facilitate the work. In the use of some solutions in particular, and all solutions in general, it is well for the spraymen to be provided with rubber or oilskin coat, hat and gloves, as this will prevent any undue irritation from the work. Much can be accomplished by management; in having things to work closely together, that is, in arranging the water supply and place of making up the spray solutions at the same place, if possible, and, if circumstances will permit, to have both where the spraying is to be conducted. There is much in business management on the farm.

THE USE OF A PUMP ON A FARM.

Not only can a spray pump be used in applying all insecticides and fungicides, in preventing the distribution of injurious insects and plant diseases on most crops, but it can also be used in other ways. The pump can be used in whitewashing outbuildings. By straining the whitewash into the spray barrel and applying to the barn through the nozzle, a fairly good job of whitewashing can be done in a comparatively short space of time; likewise, the pump can be used in disinfecting chicken houses, stables, etc., by spraying the interior walls. Thus the pump should be considered a necessary piece of machinery on the farm.

SPRAY PUMP MANUFACTURERS.

It is not for us to call attention to any particular make or size of pump for the purpose of advertising it, for we represent no manufacturer. We consider it our duty to the orchardists and farmers of the state to give our opinion, when asked, from our practical experience in the use of the various spray pumps. As to the general type and even make of pump that will be more serviceable, our position being with pumps as with insecticides: When we have proven their use and practicability by experience, we are ready to endorse them.

The catalogues of most firms are well illustrated, and it is wise for those anticipating purchasing a pump to secure these from many firms and select the one suited to his work. To this end the following list of manufacturers and dealers in pumps and supplies is given:

Griffith & Turner Co., Baltimore, Md.
Gould's Mfg. Co., Seneca Falls, N. Y.
The Deming Co., Salem, O.
Morril & Morley, Benton Harbor, Mich.
Field Force Pump Co., Elmira, N. Y.
Myers Pump Co., Ashland, O.
Geo. H. Stahl, Quincy, Ill.
Spray Motor Co., Buffalo, N. Y.
L. H. Orndorff, 203 7th street, Washington, D. C.
F. W. Bolgiano & Co., 935 B stret, Washington, D. C.

WHAT'S THE USE OF SPRAYING?

There is no one thing that concerns fruit growers which is more strongly advocated by some and more severely criticised by others than spraying of fruits. Not infrequently do we hear one voice his opinion regarding the matter as follows: "It don't pay; I have tried it! There is nothing in it." The incentive to such remarks is generally the result of an unsuccessful attempt at spraying, and the whole process is branded as a failure; but in these it is generally the result of carelessness or of a mistaken understanding of the proper methods of making and handling the spray mixtures.

Any quantity of evidence could be given in citing actual tests from carefully conducted experiments proving the great increase in yield and quality of various fruits and truck crops by judicious treatment in the form of spraying. Some of them may be given as follows: Recent work at the Geneva Experiment Station, New York, has shown conclusively, after several years' trial, the decided gain in spraying potatoes for blight and bugs. As an example, giving figures on a total area of 61 and one-sixth acres sprayed in the six experiments in the different parts of the State of New York, there was a total increase of 3.440 bushels in yield, or an average of 61.24 bushels per acre. At 50 cents per bushel the increase was worth $1,873.00. Subtracting from this amount the total expenses of the spraying, $296.49, there is a remainder of $1,576.51, which the total net profit. This is at the rate of $25.77 per acre. Does this pay?

Again, actual tests in the orchard of this Experiment Station in spraying for the codling moth, the insect which causes the wormy apples, showed the following data: On the trees which were sprayed twice during one season, once when the blossoms fell and again about the first of July, we secured 90 perfect apples and 10 wormy ones in every 100. On unsprayed trees 10 perfect apples per 100. Did these sprayings pay?

Similar tests at the Delaware Experiment Station, conducted recently, gave like results. Workers at Cornell University, and at the Missouri, and Illinois Experiment Stations have shown 40 per cent. improvement in spraying the foliage of plum, peach and apple in early spring to control plum curculio. Professor Corbett found in conducting tests of spraying for apple scab, in West Virginia, that the results showed a gain of 80 per cent. on treated trees.

Three years' test of spraying potatoes at this Experiment Station showed an average increase of 52 per cent. on the sprayed fields, spraying three or four times from June to September. On late varieties, when no blight was present, experiments in New York show a net profit of $11.00 per acre when potatoes were only twenty-five cents per bushel. It cost there four to six dollars per acre to give five applications of the spray per season to potatoes. This includes labor for man and team and wear on sprayer, labor being estimated at seventeen and one-half cents per hour, which is more than is usual in this State. Here we could usually spray at a cost of less than one dollar per acre for each spraying. Labor is the principal expense after the spraying outfit is secured, as the materials cost comparatively little.

One way in which persons not altogether familiar with the process of spraying are very apt to become discouraged and dissatisfied with the results obtained is they are too likely to think that one remedy ought to be a cure-all rather than a preventative for one thing, and because such does not prove to be the case in one or two trials, they are led to wrong conclusions and set the job aside as a failure. Spraying is merely one of the sanitary measures that necessarily go with successful fruit raising; it is a preventative, rather than a curative. Bordeaux mixture is not an efficient remedy against the attacks of insects, neither will Paris green successfully prevent apple scab or bitter rot of apples, but a combination of the two remedies, if properly handled, will prove an efficient barrier against a variety of troubles. Spraying is an expensive and tedious process, and it is not worth doing at all unless it is done well and done at the right time. That does not mean that it is necessary to spray eight or ten times during the season in order to get results. Three thorough applications, made at the proper time, ought to insure a good percentage of most crops in an ordinary season.

We do not believe that spraying is the most essential requisite to successful fruit culture. We do not even believe that it is the only means that should be employed to hold in check the numerous insect and fungus pests of cultivated crops. But we do believe that, in this age of San Jose and other scale insects, codling moth, peach tree borer, apple scab, apple canker and blight, brown rot and other injurious insects and diseases, he is wise who insures his fruit and trees against the ravages of these pests by a judicious use of the spray pump. Every one who owns a fruit tree of any kind should spray that tree or cut it down. This obligation should rest not alone upon those who are in the business of fruit growing. It should apply as well to the farmer who grows fruit only for family use, and to the dweller in towns or cities who grows only a few trees on the back yard or on a vacant lot. It should apply with particular force to the last two classes. The progressive horticulturist knows that the health, even the life of his trees, the quality of his fruit, and, hence, the degree of his success often times depends on the right use of the spray pump.

The time may have been when all that was necessary to successful fruit growing was to plant and let nature do the rest. That time, if it ever existed, is past. To make them pay, modern orchards must be cared for and managed like any other business. Spraying is a necessary part of correct management and the best kind of insurance against failure from insects and disease.

THE PRINCIPAL PLANT DISEASES AND INSECTS.

How to Recognize Them and How to Control Them.

In this list the various crops or plants are arranged alphabetically and the most common or injurious insects and diseases are given for each. Such brief descriptive notes are given for each as are necessary to enable the reader to distinguish between the different kinds of injury found on any one crop. A brief mention of the best treatment is given. For more complete instructions about any insecticide or fungicide refer to the first part of this bulletin. For more complete descriptions of insects see Bulletin 101, of this Experiment Station.

ALFALFA.

DISEASES.

LEAF-SPOT *(Pseudopeziza medicaginis)*. The leaves turn yellow and are covered with small dark-colored spots. Treatment: Mow and rake off the diseased hay when disease appears. Frequent cuttings keep down the disease.

DODDER *(Cuscuta species)*. A slender, yellow, leafless vine grows in masses on the plants. Controlled by cutting out the affected spots in the field before the dodder seeds. Use clean seed.

INSECTS.

There is no particular pest on alfalfa in this state, save the injury done at times to the foliage of the plant by little jassids and sometimes grasshoppers. In practice there are no means to successfully combat either pest.

APPLE.

DISEASES.

SCAB *(Venturia inaequalis)*. Dark, scabby spots, usually with a faint white line around them on the surface of the apple (Fig. 20); not extending into the flesh, but may cause the fruit to crack; also causes olive-colored spots on leaf. Spray with Bordeaux mixture

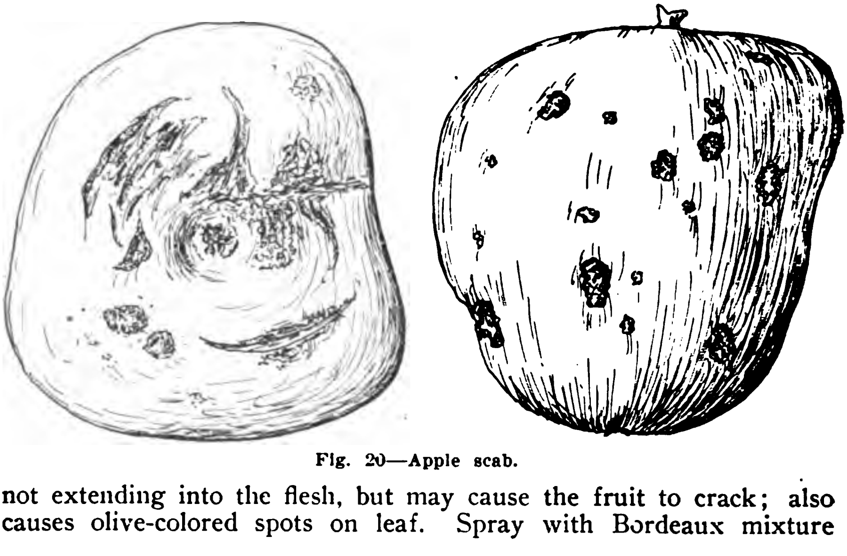

Fig. 20—Apple scab.

just before buds open and again after the petals fall. Better results will be obtained by spraying again after ten days, or if rainy, giving a fourth or fifth application at ten-day intervals. Some varieties are resistant.

BITTER-ROT *(Glomerella rufomaculans)*. Slightly sunken dark-brown rotten areas on fruit and extending deeply into the flesh; bitter tasting. The surface of the spots show concentric rings and may increase in size until the whole apple is covered. Controlled by five or six applications of Bordeaux mixture at two-week intervals beginning about June 15th. Also gather and destroy the rotten fruit and cut out and burn limb cankers.

FRUIT-SPECK. Late in the season apples may become specked with small, black, sunken spots, due to the attacks of some fungus through the lenticels on the surface. Its further spread is prevented by cold storage.

WATER CORE, causing hard, watery spots in the apple flesh, and INTERNAL BROWN SPOT are diseases not yet well understood.

FLYSPECK *(Leptothyrium pomi)* and other diseases caused by small fungi growing on the fruit surface and often seriously discoloring it can be prevented by spraying with Bordeaux mixture when the fruit is one-fourth grown.

POWDERY MILDEW *(Sphaerotheca mali)* causes a whitish, mildewed appearance on the leaves and young twigs especially in the nursery, where it can be treated with frequent sprayings with Bordeaux mixture or ammoniacal copper carbonate, and thus prevent the great reduction in growth occasioned by the disease.

RUST *(Gymnosporangium sp.)* causes bright, yellow-colored, thickened spots, one-fourth inch wide on the leaves. One stage of the fungus is the cedar apples on the red cedar. Spraying with Bordeaux mixture after the blossoms fall is a partial preventive. Removal of cedar trees near the orchard will also help. Some varieties are especially susceptible to the disease.

The apple is also affected with a *brown rot* similar to that of the plum and peach. It usually starts from injuries made by birds or insects, etc. Other *rots* attack the ripe fruit and are best prevented by care in handling and by cold storage. Rotten and specked fruit should be separated from the better grades.

CROWN-GALL. Rough knots thicker than the root and with or without an unnatural abundance of fibrous roots indicate this disease. The hard woody gall is not so injurious as the soft form, but it is better to only plant trees with perfect roots. For control in nursery see bulletin 100, Bureau Plant Industry, U. S. Department of Agriculture.

HAIRY-ROOT is a somewhat similar disease indicated by an abundance of stiff, wiry, fibrous roots. Trees so injured should not be planted.

ROOT-ROT. Various fungi or soil conditions cause the death and decay of roots of apple and other trees. Such trees show much reduced growth and small yellow leaves. They had better be dug up and burned.

WOOD-ROT fungi attack the heart wood, especially of trees poorly cared for. Their entrance through wood surface exposed by pruning, cankers, ***wind break***, etc., can be prevented by painting the exposed surface as indicated under canker.

BLACK-ROT *(Sphaeropsis malorum)*. Similar to bitter rot, darker colored, not extending so deeply into the flesh. Treatment same as for scab. See also canker and leaf-spot.

BLIGHT *(Bacillus amylovorus)*. See pear diseases.

LEAF-BLIGHT OR LEAF-SPOT *(Phyllosticta and Sphaeropsis malorum)*. Several fungi cause nearly circular brownish spots one-fourth inch or less across on apple leaves. Spraying as for bitter rot or scab is effective against them.

CANKER *(Sphaeropsis malorum, Bacillus amylovorus, etc.)*. Somewhat sunken, roughened, ulcerlike areas in bark, which is entirely or partially killed, exposing the wood to evaporation. Trim out the injured portion and paint with white lead in linseed oil. In spraying with Bordeaux mixture spray the body of the tree. Cankers may also start from *Sunscald,* caused by drying on the southside of tree in winter or from *frost cracks.*

COLLAR-ROT, the common decay of bark at base of tree can be treated as canker.

INSECTS.

WOOLLY APHIS *(Schizoneura lanigera)*. A plant louse; larvæ appear as a cottony mass; does injury by sucking; attacks either root or branches. Secure clean nursery stock; apply a handful of tobacco dust when planting trees. Apply tobacco dust to roots later. When on branches spray with 15 per cent. kerosene emulsion.

BORERS, ROUND-HEADED *(Saperda candida)*, FLAT-HEADED *(Chrysobothris femorata)* appear as larvæ (white worm); attack trunk by boring and eating. Remove borers in October and again in March or April.

FRUIT-TREE BARK BEETLE *(Scolytus rugulosus)*. Small, black beetle; attacks trunk and branches by boring "shot holes" into wood. (Figures 21, 22, 23.) Keep all brush cut out of orchard. Destroy infested parts.

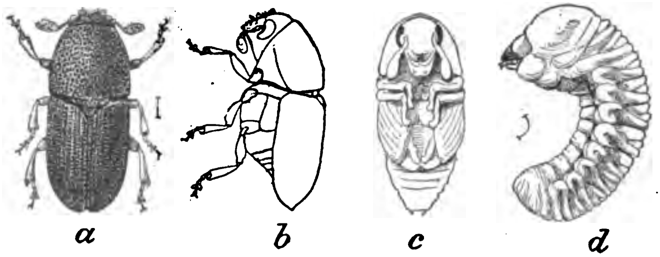

Fig. 21—Fruit-Tree Bark Beetle; a, adult beetle; c, pupa; d, larva. (After Chittenden, U. S. Dept. Agriculture.)

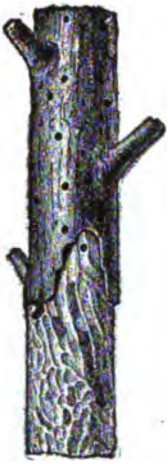

Fig. 22—Showing galleries of Fruit-Tree Bark Beetle, under bark of twig. (After Chittenden, U. S. Dept. Agriculture.)

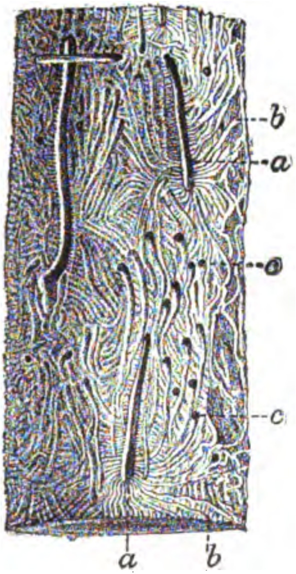

Fig. 23—Showing work of Fruit-Tree Bark Beetle, on a twig of apple. (After Chittenden, U. S. Dept. Agriculture.)

SAN JOSE SCALE *(Aspidiotus perniciosus)*. Small, roundish scale insect; injury by sucking, badly infested tree shows ash-gray appearance. Apply lime-sulphur wash just before buds open in spring.

OYSTER-SHELL SCALE *(Lepidosaphes ulmi)*. Small scale, dark in color, shape of an oyster; injury by sucking. Apply lime-sulphur wash in early spring, or 15 per cent. kerosene emulsion about the middle of May.

SCURFY SCALE *(Chionaspis furfura)*. Small, whitish scale, triangular or pear shape; injury done by sucking. (Figure 24.) Apply lime-sulphur wash in early spring, or 15 per cent. kerosene emulsion about middle of May.

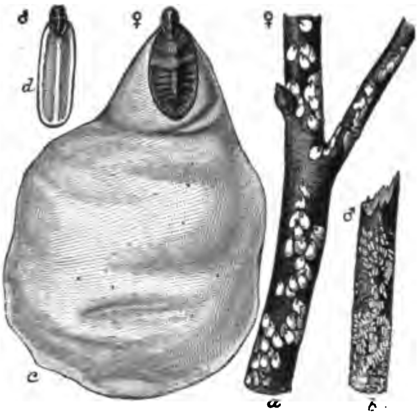

Fig. 24—The Scurfy Scale; a, c, females; b, d, males; a, b, natural size; c, d, enlarged. (After Howard, U. S. Dept. Agriculture.)

APPLE APHIS *(Aphis sp.)*. Small, green plant lice; suck juices from leaves in early spring. Apply 15 per cent. kerosene emulsion.

APPLE-TREE TENT-CATERPILLAR *(Malacosoma americana)*. Hairy caterpillar, eats foliage of trees. Apply arsenical or destroy tents at night with torch or by cutting out.

FALL WEBWORM *(Hyphantria cunea)*. Small caterpillar; eats foliage of tree. (Figure 25.) Apply arsenical or destroy web.

CODLING MOTH *(Carpocapsa pomonella)*. Small larva; injures apple by eating into it, causing "wormy" fruit. Spray with arsenical when blossoms fall. Repeat spraying in about ten days. Repeat spraying about 20th of July.

PLUM CURCULIO *(Conotrachelus nenuphar)*. Small beetle; eats foliage in early spring. Later females do injury by depositing eggs in fruit. Spray foliage with arsenical; jar trees with a sheet under same in early morning. Repeat until beetles diminish in number.

APRICOT.

Apricots are subject to much the same diseases and insects as peach, with a similar treatment.

ASPARAGUS.

DISEASES.

RUST *(Puccinia asparagi)*. The first stage appears as yellow spots on the young stalks in early summer. The later stage shows as very small, brown blisters all over the plant, which cause it to die before it has stored enough food in the crown for next year's growth. Cut and burn the dead tops and cultivate afterward; cultivate early in the spring, keep all stalks cut off clean till the last of June and destroy all stray plants. Spray frequently after August first with soap Bordeaux mixture, or dust with flowers of sulphur every two weeks.

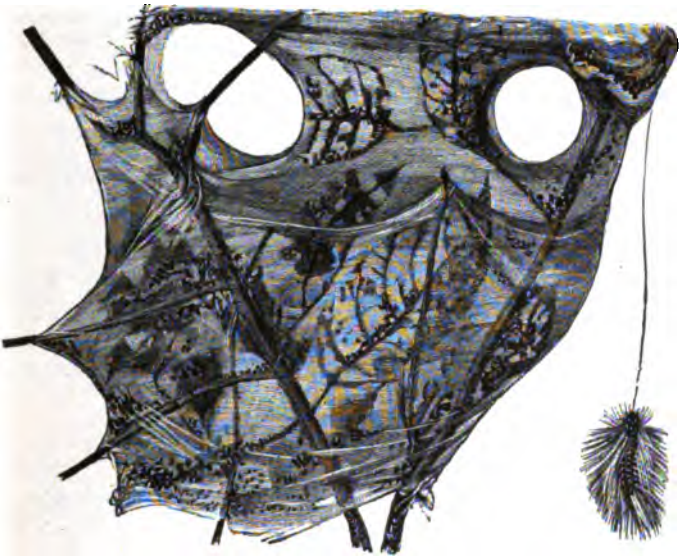

Fig. 25—The Fall Web-Worm; suspended larva and sections of web. (After Riley.)

LEOPARD SPOT AND ANTHRACNOSE cause much less injury.

INSECTS.

ASPARAGUS BEETLE *(Crioceris asparagi)*. Small beetle; eats the plant. Spray with arsenical, adding resin soap after cutting season. Apply air-slaked lime when young first appear.

TWELVE-SPOTTED ASPARAGUS BEETLE *(Crioceris duodecimpunctata.)* Treatment same as for above species.

ASTER.

YELLOWS. China asters are affected with a disease similar to peach yellows. Destroy affected plants.

BARLEY.

RUST AND SMUT, etc. See wheat, which has about the same troubles.

BEAN.

DISEASES.

ANTHRACNOSE *(Colletotrichum lindemuthianum)* causes ulcer-like spots on leaves and pods. Plant perfect, unspotted seeds. Spray when plants are two to three inches high with Bordeaux mixture; repeat in two weeks and again after they bloom. The wax varieties are more susceptible to the disease.

BLIGHT *(Bacterium phaseoli)* causes watery spots in pods and dead patches on the leaves. Spraying frequently with Bordeaux mixture is a partial preventive. Do not plant beans on infected soil.

DOWNY MILDEW *(Phytophthora phaseoli)*. A white mildew appears on the pods. It is very destructive to Lima beans. Spraying frequently with Bordeaux mixture, and, after the pods form, with ammoniacal copper carbonate will greatly reduce the disease. Plant healthy seed on well-drained soil.

RUST, LEAF-SPOT AND POWDERY MILDEW occur less frequently and are not very destructive.

INSECTS.

BEAN LEAF-BEETLE *(Cerotoma trifurcata)*. (Figure 26.) Apply arsenical; repeat, if necessary.

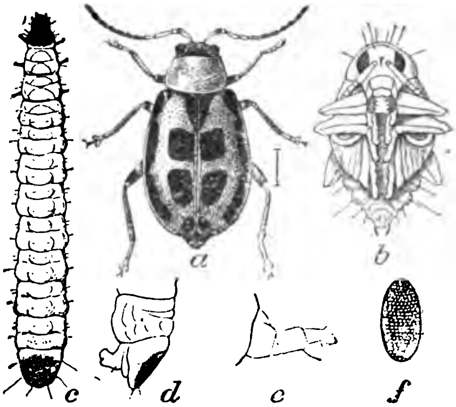

Fig. 26—The Bean Leaf-beetle; a, adult beetle; b, pupa; c, larvæ. (After Chittenden.)

COMMON BEAN WEEVIL *(Bruchus obtectus)*. When beans are stored apply carbon bi-sulphide.

BEAN LADYBIRD *(Epilachna corrupta)*. A spotted beetle; injures by eating foliage, apply arsenical.

TWELVE-SPOTTED CUCUMBER BEETLE *(Diabrotica duodecimpunctata)*. Small, spotted beetle; injures by eating foliage. Apply arsenical.

BEET.

Leaf-spot *(Cercospora beticola)* may cause some loss to the beet foliage. Bordeaux mixture every two weeks will keep it off. Potato scab and several other less important root and leaf diseases occur on the beet.

BLACKBERRY.

Anthracnose, Crown-gall, Leaf-spot and Rust of the blackberry are the same as those of the raspberry, which see. The latter two are more frequently seen on blackberry than on raspberry.

Rose Scale *(Aulacaspis rosae)*. Whitish scale insect; injures by sucking. Destroy badly infested canes. Spray with 10 to 12 per cent. kerosene emulsion during May.

Raspberry Root-borer *(Bembecia marginata)*. Larva about an inch long; bores into roots. Destroy infested parts. See raspberry insects.

BLUE GRASS.

In wet seasons blue grass lawns may be seriously injured by *Rust* and *Mildew (Erysiphe graminis)*. Spraying with Bordeaux mixture would probably be beneficial, or dust with sulphur for the mildew.

BROOM CORN.

See sorghum which is similarly affected.

BUCKWHEAT.

Leaf-blight *(Ramularia rufo-maculans)* produces whitened spots on the leaves and kills them, but is not destructive enough to warrant treatment.

CABBAGE.

Diseases.

Black-rot *(Pseudomonas campestris)* causes dwarfed one-sided or partly rotted heads. It is first indicated by darkened veins or fibers. Soak seed fifteen minutes in 1 to 1000 solution corrosive sublimate or formalin, 1 part to 250 of water. Plant strong, healthy plants and keep them so by good cultivation. Avoid wet situations and infected land, especially for plant bed. Destroy diseased plants. No very satisfactory treatment is known.

Club-root *(Plasmodiophora brassicae)*. The roots are much swollen and distorted and the heads make poor growth. Fresh lime 75 bushels per acre, worked into freshly plowed ground in the fall is beneficial for infected land. The fungus lives in the soil for many years and may also live on mustard, turnips and many weeds like shepherds purse, peppergrass, etc. Avoid low wet ground. Destroy diseased plants.

WILT *(Fusarium sp.)*. The fungus lives in the soil and attacks the plants through the roots causing wilt and dropping of the leaves. Avoid infected land. No good treatment known.

SOFT-ROT *(Bacterial)* usually follows other diseases causing the heads to decay and become foul smelling. No treatment.

DOWNY MILDEW *(Peronospora parasitica)*. The young leaves in the plant bed show a downy appearance in spots which finally die. Older plants are sometimes similarly affected in the outer leaves. Reduce the amount of water given plants and spray with Bordeaux mixture.

Other not very serious diseases are *White-rust (Albugo candida)*, *Powdery mildew (Oidium brassicae)* and *Leaf blight (Macrosporium brassicae)*. The later causes the black spots on the outer leaves of heading cabbage.

INSECTS.

CABBAGE MAGGOT *(Pegomya brassicae)*. Larvae injure roots. Place tarred paper card around young plant. Apply crude carbolic acid emulsion to plants after they are set. Repeat once a week until about May 15th.

IMPORTED CABBAGE-WORM *(Pontia rapae)*. Green larvæ; eat foliage of plants. Apply arsenical as dust or spray. Repeat as necessary.

CABBAGE LOOPER *(Autographa brassicae)* and CABBAGE MAMESTRA *(Mamestra trifolii)*. Larvae eat foliage. Spray with arsenical. Plant turnips, radishes, or other plants of mustard family for trap crops.

CUT WORMS. A number of species of cut worms injure this plant as well as other crucifers. Cultural methods together with poisoned baits just before the plants are put out will aid in suppressing the pests.

CABBAGE PLANT LOUSE *(Aphis brassicae)*. Sucking insect. Apply 15 per cent. kerosene emulsion.

HARLEQUIN CABBAGE-BUG *(Murgantia histrionica)*. A bright red, yellow and black mottled bug; injures by sucking. Plant trap crop of kale and mustard. Kill bugs on these plants by applying pure kerosene to plants or by cutting.

CALLA.

SOFT-ROT *(Bacillus aroideae)*. The leaves rot off near the ground. Select healthy corms for planting and change the soil of beds every three or four years.

CANTELOUPE.

DISEASES.

LEAF-BLIGHT *(Alternaria brassicae nigrescens)*. Somewhat circular brown spots appear on the leaves and finally kill them. The melons on affected vines are of poor quality. Spray with Bordeaux mixture at intervals of two weeks from the first bloom until fruit is nearly grown. Resistant strains are being developed.

WILT OR BACTERIOSIS *(Bacillus tracheiphilus)*. The whole vine or entire branches suddenly wilt, though others near by may remain healthy. Pull and burn withered vines. Keep off the squash bugs. (See under cucumber insects).

DOWNY MILDEW AND ANTHRACNOSE are the same as on cucumber which see. Some minor leaf and fruit diseases and another wilt also occur, but not frequently.

INSECTS.

MELON APHIS *(Aphis gossipii)*. Green plant louse; does injury by sucking. Apply 15 per cent. kerosene emulsion.

FLEA BEETLE *(Epitrix cucumeris)* Small dark beetles, very active, spray with an arsenical with Bordeaux mixture, then apply wood ashes or air slaked lime.

CARNATION.

DISEASES.

RUST *(Uromyces caryophyllinus)*. Small, dark purplish brown spots breaking through the leaf surface. Destroy diseased portions and use clean stock for propagation. Spray with Bordeaux mixture adding 2 pounds soap to the barrel. Some varieties are more subject to the rust than others.

STIGMONOSE. Many small brownish spots and yellowing of affected leaves due to aphid punctures and associated with bacteria appear on the foliage. (See methods of controlling aphis.)

LEAF MOULD *(Heterosporium echinulatum)* causes dark, unsightly often ring-like spots on the leaves, etc. Spray with Bordeaux mixture every two weeks, adding soap to make it stick.

STEM-ROT *(Rhizoctonia)*. No good remedy.

Some other less prominent fungus diseases are *leaf spot, anthracnose* and *wilt*. Also a disease in which the buds mature but fail to open, has been seen in Maryland.

INSECTS.

APHIS *(Aphis sp.)*. Plant louse, injures by sucking. Apply firtree oil, 1 to 20, or common soap, 5 oz. to one gallon water.

CARROT.

LEAF-SPOT. See celery leaf-spot which is the same.

CAULIFLOWER.

The cauliflower insects and diseases are about the same as those of cabbage.

CELERY.

DISEASES..

LEAF-BLIGHT *(Cercospora apii)*. The outer leaves show light brown spots, especially about the edges, and finally die. Spray from three to five times with Bordeaux mixture.

HEART-ROT *(Bacterium apii)*. The heart is blackened and decayed.

PITHINESS is due to lack of care in selecting seed from good plants.

INSECTS.

CELERY LOOPER *(Plusia simplex)*. Larvæ eat foliage. Apply arsenical.

CATERPILLAR *(Papilio polyxenes)*. Larvæ foliage. Apply arsenical.

CHERRY.

DISEASES.

LEAF-SPOT *(Cylindrosporium padi)*. Brown circular spots on the leaves. They may become so abundant that the leaf .falls and often leaves the cherry tree without foliage early in summer. Weak Bordeaux mixture as soon as the leaves are out and again two weeks later.

POWDERY MILDEW *(Podosphaera oxyacanthae)* causes a whitish appearance on the young twigs and leaves. Treat as for leaf-spot.

BLACK-KNOT *(Plowrightia morbosa)*. See under plum.

BROWN-ROT. See under peach.

TWIG-BLIGHT. See under peach.

ROOT-ROT. Great difficulty has been experienced in recent years in growing sweet cherry trees. A few years after planting, the root dies and of course soon after the whole tree follows. The cause is said to be lack of harmony between stock and scion and the trees grafted on Mazzard stock are said to do much better.

INSECTS.

CHERRY APHIS *(Myzus cerasi)*. Green plant louse; injures by sucking; apply 15 per cent. kerosene emulsion.

PLUM CURCULIO *(Conotracheus nenuphar)*. See apple.

PEAR SLUG *(Eriocampoides limacina)*. Dark green slug; eats upper side of foliage, apply arsenical or dust with air-slaked lime.

CHERRY SCALE *(Aspidiotus forbesi)*. Small, dark scale, similar to San Jose scale. Apply lime-sulphur wash in early spring, while trees are dormant.

CHESTNUT.

DISEASES.

LEAF-SPOT *(Septoria ochroleuca)*. Small brown spots on leaves. Spray with Bordeaux mixture. The Japan varieties are not much troubled.

POWDERY MILDEW *(Phyllactinia suffulta)* forms white patches on leaves in autumn, does little damage and could be controlled by applications of Bordeaux mixture or sulphur dust.

GREEN MOULD *(Penicillium)* often spoils the nuts, entering through the stigma or insect injuries. No remedy.

Wild chestnut trees often die through the injuries to the roots by stock and fires and by parasitism of wood-rotting fungi.

INSECTS.

LARGER CHESTNUT WEEVIL *(Balaninus proboscideus)*, LESSER CHESTNUT WEEVIL *(Balaninus rectus)*. Clay-colored snout beetles. Larvae injure nuts. Gather nuts as soon as they fall. Sell, or put in tight boxes as soon as possible to catch the larvae when they come out of the nuts.

CHRYSANTHEMUM.

DISEASES.

LEAF-SPOT *(Septoria chrysanthemi)*. Dark colored spots on the leaf. Spray with Bordeaux mixture or if it is undesirable to discolor the leaves with this spray, use ammoniacal copper carbonate or other clear fungicide.

RUST *(Puccinia chrysanthemi)*. Dark brown, raised spots as large as a pin head scattered over the leaves. Pick off and burn rusted portions and use healthy shoots for propagation. Often quite serious.

INSECTS.

APHIS *(Aphis sp.)*. Plant louse, injures by sucking. Apply fir-tree oil 1 to 20, or common soap solution.

TWO-SPOTTED RED-SPIDER *(Tetranychus bimaculatus)*. See geranium.

CLOVER.

DISEASES.

ANTHRACNOSE *(Colletotrichum sp.)*. Affects young plants in summer, killing the stem and leaves. New and not yet thoroughly studied.

DODDER *(Cuscuta epithymum)*. See alfalfa dodder.

BROOM RAPE *(Orobanche minor)*. A yellowish leafless weed as tall as the clover and attached to its root. Destroy whenever found. It is not yet common in Maryland.

RUST *(Uromyces trifolii)*. Small rusty elevated spots on leaves in summer and autumn. Usually not so injurious as to make treatment profitable.

BLACK-SPOT *(Phyllachora trifolii)*. Small black spots on leaves. Not very injurious. Another leaf-spot also occurs.

INSECTS.

CLOVER ROOT-BORER *(Hylastinus trifolii)*. Larva injures roots of plants. Plow infested fields when hay crop is cut.

CLOVER STEM BORER *(Languria mozardi)*. Beetle appears in June; larva works in stem. Keeping fields cut in summer and fall will control it.

CLOVER HAY WORM *(Hypsopygia costalis)*. Larvae injure hay in mow. Do not stack hay two successive seasons in the same place. Clean barn out before putting in new hay.

CORN.

DISEASES.

LEAF-BLIGHT *(Helminthosporium inconspicuum)*. Long, light brown or withered stripes appear on the leaves; often the lower leaves are entirely killed and dry up green. No remedy.

SMUT *(Ustilago zeae)*. Large swellings appear on the ear and other parts, white at first and later filled with black dust. Cut off and burn the smutted portions before dry. Often worse on early sweet corn varieties, but does not do enough damage on field corn to pay for treatment; not poisonous to stock.

RUST *(Puccinia sorghi)*. Small, oblong, rusty specks on leaves. Does little damage in this State.

WILT *(Pseudomonas Stewarti)* causes wilt of early sweet corn. Grow resistant varieties.

INSECTS.

CORN ROOT-WORM *(Diabrotica duodecimpunctata)*. 12-spotted beetle: larvæ eat small roots and burrow into larger roots and stalk of young corn. Rotation of crops.

CORN ROOT-LOUSE *(Aphis maidi-radicis)*. Lice suck the roots of plant. Rotation of crops and cultural methods.

CORN-STALK BORER *(Diatraea saccharalis)*. Brown-spotted caterpillars bore into the young stalks. Destroy old stalks of infested field. Rotation of crops.

CORN EAR-WORM *(Heliothis obscura)*. Larva injures ear of corn. Fall plowing. Rotation of crops.

ANGOUMOIS GRAIN-MOTH *(Sitotroga cerealella)*. Larva feeds in kernel of corn that is stored or after harvest. Fumigate with carbon bi-sulphide.

COWPEA.

WILT *(Neocosmospora vasinfecta tracheiphila)*. The vines wilt and are stunted in growth. If the disease occurs in Maryland the Iron cowpea, which is resistant to it, can be grown. The *Root-knot* disease of the South can be overcome in the same way.

A *Leaf-spot* disease also occurs, but is not serious.

The cowpea in this state is so far remarkably free from serious diseases. For insects see bean.

CRANBERRY.

The cranberry is not grown in Maryland but is native in our mountain bogs. Its diseases and insects are well treated in Farmers' Bulletins Nos. 221 and 178 respectively, U. S. Department of Agriculture.

CUCUMBER.

DISEASES.

DOWNY MILDEW *(Plasmopara cubensis)*. Yellowish angular spots on the leaves, which soon die as if frosted. Spray with Bordeaux mixture every ten days after July first. When spraying is to be practiced the vines should be planted so that a sprayer can be hauled through them.

ANTHRACNOSE *(Colletotrichum lagenarium)* causes circular dead spots on the leaves and more elongated ones on the stem. Spray with Bordeaux mixture as soon as the disease appears. Also occurs on melons.

WILT, described under cantaloupe also occurs on cucumber.

INSECTS.

PICKLE WORM *(Diaphania nitidalis)*. Larva bores into cucumber.

STRIPED CUCUMBER BEETLE *(Diabrotica vittata)*. Beetle eats foliage. (Figure 27.) Apply arsenical, wood ashes, air-slaked lime, etc.

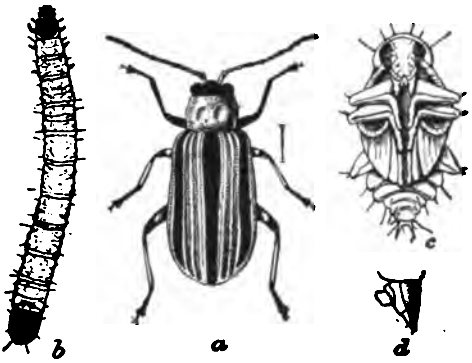

Fig. 27—The Striped Cucumber Beetle. (After Riley.)

TWELVE-SPOTTED CUCUMBER BEETLE *(Diabrotica duodecimpunctata)*. Beetle eats foliage. See above.

SQUASH LADYBIRD *(Epilachna borealis)*. Larva injures foliage. Apply arsenical.

COMMON SQUASH-BUG *(Anasa tristis)*. Adult insect punctures vines. Clean culture. Destroy vines after securing crop. Catch bugs and destroy eggs.

CURRANT

DISEASES.

LEAF-SPOTS *(Septoria ribis* and *Cercospora angulata)*. Spotted leaves which fall prematurely. Spray with Bordeaux mixture as the leaves are unfolding and twice more at two-week intervals.

ANTHRACNOSE *(Gloeosporium ribis)*. Spots the leaves and stems. Treat as for leaf-spot.

MILDEW. See under gooseberry.

INSECTS.

IMPORTED CURRANT-BORER *(Sesia tipuliformis)*. Larva eats into center of stem where it bores up and down. Destroy all injured canes or stems.

SAN JOSE SCALE *(Aspidiotus perniciosus)*. See apple.

GOOSEBERRY SPAN-WORM *(Cymatophora ribearia)*. Larva eats foliage. Apply arsenical or helebore.

IMPORTED CURRANT WORM *(Pteronus ribesii)*. Larva eats foliage. Apply arsenical.

DEWBERRY.

See blackberry for its insects and diseases.

EGG PLANT.

ANTHRACNOSE *(Gloeosporium melongenae)*. Slightly sunken areas in fruit.

A leaf-spot occurs on the leaves; some diseases of potato also attack the egg plant.

EGGPLANT FLEA-BEETLE *(Epitrix fuscula)*. Beetles eat foliage. Apply arsenical with Bordeaux mixture or wood ashes and air slaked lime.

GERANIUM.

A rot causes the young plants to die in the cutting bed and a leaf-spot mars the foliage. Both are caused by bacteria. Use clean soil and disinfect benches. Frequent spraying with Bordeaux mixture will keep them down.

MEALY BUG *(Pseudococcus citri)*. Injures by sucking. Contact insecticide. Kerosene or soap emulsion.

RED SPIDER *(Tetranychus bimaculatus)*. Spray with soap and water or water alone, hitting both sides of leaves. The mite seems to thrive in dry atmosphere.

GINSENG.

This plant is now being cultivated to a limited extent. Its diseases are described in Bulletin No. 219, Cornell Experiment Station.

GOOSEBERRY.

POWDERY MILDEW *(Sphaerotheca mors-uvae)*. Grayish mildewed areas on leaves and fruit. The leaves fall early and the fruit is seriously injured. Spray every two weeks after the buds swell with potassium sulphid, 1 oz. to 2 gallons of water.

LEAF-SPOT. See under currant.

GOOSEBERRY FRUIT-WORM *(Zophodia grossulariae)*. Larva burrows into berry. Hand picking. Dust bushes with air-slaked lime early in spring, repeating if washed off. This will deter moths from laying eggs. For other insects see currant.

GOURD.

Diseases about the same as for melons, cucumber, etc.

GRAPE.

DISEASES.

BLACK-ROT *(Guignardia bidwellii)*. The grapes rot, turn black and shrivel up. The disease may also spot the leaves and stems. Clean up and burn diseased leaves, fruit, etc. Spray vines, posts, etc., thoroughly, with Bordeaux mixture when buds are swelling. Spray again in two weeks when grapes are in bud. Keep the bunches of grapes covered with Bordeaux mixture until almost ripe. This will take from six to eight sprayings. Ammoniacal copper carbonate can be used for the last two times to avoid staining the fruit.

ANTHRACNOSE *(Sphaceloma ampelinum)*. Circular, slightly sunken spots with a lighter colored center appear on the fruit. It also spots the leaves and vines. Treat as for black-rot. The earlier sprayings are more important with this disease.

DOWNY MILDEW *(Plasmopara viticola)*. Yellow areas appear on the upper side of the leaves and underneath them a downy patch. It also attacks the fruit, causing a brown rot. Spray as for black-rot, except that the earlier sprayings are not necessary.

POWDERY MILDEW, WHITE-ROT, BITTER-ROT, etc., occur but are not so important and are controlled by the treatment which it is usually necessary to give for some of the above described diseases.

INSECTS.

BROAD-NECKED PRIONUS *(Prionus laticollis)*. Injures roots by boring. Dig out and destroy.

GRAPE-VINE ROOT-WORM *(Fidia viticida)*. Beetles feed on foliage, young larvæ feed on roots. Spray foliage with an arsenical. Thorough cultivation of ground.

GRAPE SCALE *(Aspidiotus uvae)*. Injures vines by sucking. Apply strong solution of whale oil soap or lime-sulphur wash.

GRAPE-VINE FLEA-BEETLE *(Haltica chalybea)*. Adult beetles and larvæ feed on the leaves. Apply arsenical with Bordeaux mixture. The latter is distasteful to the insect.

ROSE CHAFER *(Macrodactylus subspinosus)*. Adult beetles eat flower and young grapes. Handpicking. Continuous applications of arsenate of lead may assist in controlling them.

There are a number of caterpillars of some of our largest moths that feed on the foliage of grapes to some extent. All can be controlled by an arsenical.

HORSECHESTNUT.

LEAF-SPOT *(Phyllosticta sphaeropsoidea)*. This shade tree is often disfigured by the brown spots and dead leaves caused by this fungus. Spray with Bordeaux mixture when the leaves are half grown and at three week intervals afterward.

HORSE RADISH.

WHITE-RUST *(Albugo candida)* is common on leaves but does little harm. It occurs on many other plants of the mustard family.

IRISH POTATO.

See potato.

LETTUCE.

ROT OR DROP *(Sclerotinia libertiana)*. The plants wilt and rot off near the ground. Careful regulation of water and temperature in lettuce houses will do much to keep down the disease. Give good ventilation and drainage. It is not very troublesome outdoors. Diseased plants should be burned and some have had good results with sterilized soil. A top coating of sterilized soil or sand one inch thick is recommended.

DOWNY MILDEW *(Bremia lactucae)* may attack young lettuce leaves. Avoid high temperature and too much water.

TOP BURN. The browning of the leaf tips is due to strong light after cloudy weather and too high temperature.

LILAC.

POWDERY MILDEW *(Microsphaera alni)* gives the leaves of lilac a grayish coating in autumn. It rarely does harm. Sulphur dust should control it.

OYSTER-SHELL SCALE *(Lepidosaphes ulmi)*. Common on this plant, see bulletin 111, of this Station. Apply 15 per cent. kerosene emulsion middle of May.

SAN JOSE SCALE *(Aspidiotus perniciosus)*. See apple.

MAPLE.

BLACH-SPOT *(Rhytisma acerinum)*. Large, thick, black spots on the leaves. Not serious. Burning dead leaves and Bordeaux spraying in summer would be helpful.

OYSTER-SHELL SCALE *(Lepidosaphes ulmi)*. See lilac.

MUSKMELON.

See canteloupe.

MUSTARD.

Mustard is subject to the club-root, black-rot, white-rust, and other diseases of cabbage.

OATS.

RUST *(Puccinia coronata)*. Rusty colored, dusty stripes covering the leaves. Very serious in lower portions of the state. No remedy.

SMUT *(Ustilago avenae)*. The grain is replaced by a black dust. Before sowing sprinkle formalin solution (1 pint to 50 gallons water) at the rate of one gallon to the bushel over the pile of seed, while it is being shoveled over. After two or three hours spread out to dry.

ONION.

Onions in other states have been attacked by *rot, mildew, smut, blight,* etc., but none of these have proved serious in this state. The smut is the worst trouble and is controlled by dusting sulphur in the rows when seeding, or treating with formalin before sowing.

PARSNIP.

Parsnips are subject to about the same diseases as celery, especially the leaf blight.

PARSNIP WEBWORM *(Depressaria heracliana)*. Injures by eating. Apply arsenical.

PARSNIP LEAF-MINER *(Acidia fratria)*. Larva mines the leaves. Apply arsenical early.

PEA.

DISEASES.

BLIGHT *(Ascochyta pisi)*. Stems are killed near the ground; the leaves may be spotted and the whole plant wilt and die. Plant seed free from the disease and in soil where peas, beans, etc., have not been recently.

POWDERY MILDEW *(Erysiphe communis)*. A whitish coating shows on the leaves. Spray with Bordeaux mixture when it appears and later if needed. *Leaf spot* and other leaf diseases may also attack the pea but are not very troublesome.

INSECTS.

PEA LOUSE *(Nectarophora pisi)*. Plant louse; injures by sucking. Apply 15 per cent. kerosene emulsion. Plant crop early to avoid pest as much as possible.

COMMON BEAN WEEVIL *(Bruchus obtectus)*. See bean insects.

PEA WEEVIL *(Bruchus pisorum)*. Fumigate with carbon bi-sulphide.

PEACH.

DISEASES.

YELLOWS. (Figure 28.) The fruit ripens several days or weeks be-

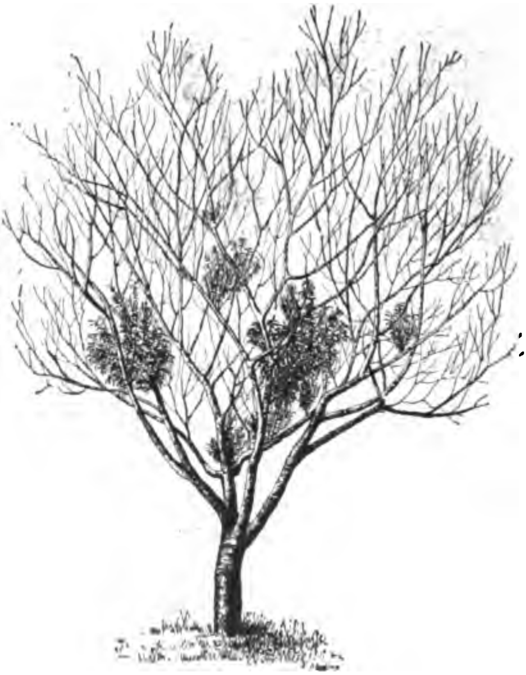

Fig. 28—Peach tree in last stages of the yellows.

fore healthy fruit of the same variety. The prematurely ripened fruit is red spotted and has red streaks through the flesh and the fruit is worthless. Later the leaf buds develop into slender twigs which have small, narrow, pointed, yellowish leaves and the tree soon dies. The disease may show on part of the tree only, though the whole tree be diseased. Examine all the trees carefully during the ripening period and afterward and pull up and burn every affected tree as soon as discovered no matter how slightly diseased. This will keep the disease down so that only a few cases appear each year, when if they are allowed to stand the disease spreads rapidly to the surrounding trees. The Maryland law requires the destruction of trees affected with the yellows.

BROWN-ROT *(Sclerotinia fructigena)*. The fruit rots with a soft, brown rot and is covered with grayish dusty spots of the fungus spores. The rotting fruit shrivels up and may hang on the trees over winter in the mummified condition. The fungus also attacks the twigs and kills them. It sometimes starts early causing *blossom-blight*. Gather and burn the rotten fruit remaining on trees or ground in fall. Prune so as to admit air and light. Select orchard sites with good soil and air drainage. Spray just before the buds open with 5-5-50 Bordeaux mixture. Spray when fruit is one-fourth inch in diameter with 3-9-50 Bordeaux mixture. Give two or three more sprayings at two week intervals if there is much danger of loss from rot. There is considerable danger of even the weak Bordeaux mixture injuring the leaves.

LEAF-CURL *(Exoascus deformans)*. As the first leaves mature, part of them become thickened, whitish and wrinkled and drop off. If many are affected the young fruit may also drop. Some varieties, as Elberta, are more subject to the disease. Spray before the buds open, with Bordeaux mixture or lime-sulphur wash. The former is better.

SCAB *(Cladosporium carpophilum)*. Also called *black-spot* and *mildew*. Black spots appear on one side of the fruit. If abundant, the fruit may shrivel or crack. Spray with 3-9-50 Bordeaux mixture the second week in June and again two or three weeks later.

CROWN-GALL. Rough projecting galls an inch or more in diameter on the root usually near the surface of the ground. (Figure 29). The affected trees make poor growth and often die. Destroy affected trees. In the nursery avoid infected soil as the disease is contagious.

GUMFLOW. Many different diseases and injuries cause a production of gum from the peach bark. A bacterial disease has this symptom and kills the bark in large patches. Badly affected trees or branches should be destroyed.

WINTER INJURY. The peach is especially subject to injury by low temperature. Trees well cared for and in vigorous condition but well hardened and not full of sap are less injured. Badly injured trees should be cut back.

LEAF-SPOT OR SHOT-HOLE *(Cercospora persica)* and other fungi or spray injury). Spots about one-eighth inch in diameter, which may drop out, leaving small holes in the leaves. Usually not serious. If numerous the whole leaf may fall.

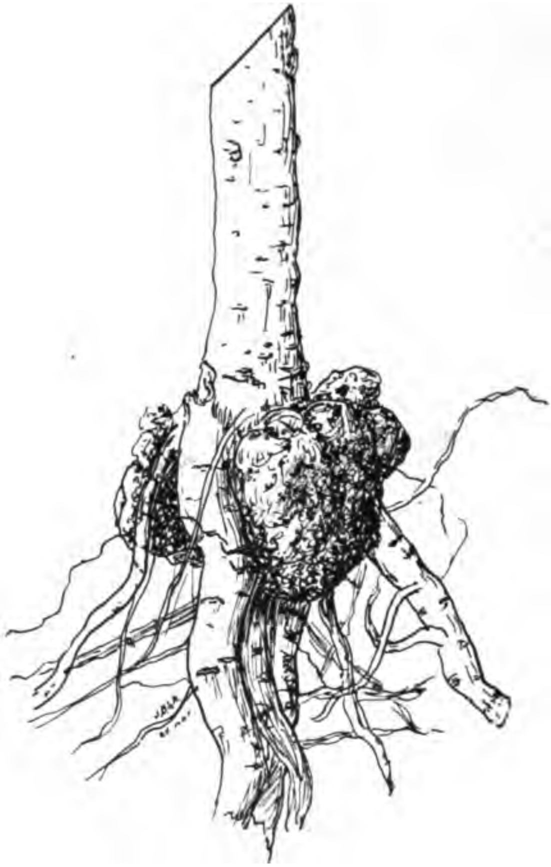

Fig. 29—Crown-gall on peach root.

Frosty Mildew *(Cercosporella persica).* Whitish patches on leaves and young twigs; usually not serious except on a few varieties, as Tilletson.

Insects.

Black peach aphis *(Aphis persicae-niger).* Dark colored plant louse; attacks roots and twigs. Treat as woolly aphis, for which see apple.

Peach-tree borer *(Sanninoidea exitiosa).* Larvae bore into trunks of trees. Remove borers in October and April.

San Jose scale *(Aspidiotus perniciosus).* See apple.

PEACH SCALE or LECANIUM *(Eulecanium nigro-fasciatum)*. Soft, rounded scale; injures by sucking. Apply 15 per cent. kerosene emulsion, about middle of May.

FRUIT-TREE BARK-BEETLE. See apple.

PLUM CURCULIO. See apple.

PEAR.

DISEASES.

BLIGHT, also called *Fire-blight* and *Twig-blight (Bacillus amytovorus)*. The twigs die from the tips backward, usually starting from flowers. The leaves on affected parts die, turn black and hang on. In many cases the disease works back into large branches or the body of the tree killing the bark and thus causing body blight or cankers. Cut out blighted portions several inches below the visible affectation, disinfecting the cut surface and frequently the knives or other tools used, in corrosive sublimate solution (1 to 1000) which can be carried on a sponge or cloth. Cut out blight especially in fall and spring before blooming time. Allow no small twigs or spurs on large branches or body of tree. Prune to vase form and frequent branching of main limbs. Occurs also on apple and quince.

CANKER AND BODY-BLIGHT. Same as for apple, but spreading more rapidly.

LEAF-BLIGHT *(Entomosporium maculatum)*. The leaves become spotted and fall early. The fruit also may be affected. Spray with Bordeaux mixture after the blossoms fall. Spray a second and third time at two weeks intervals. This treatment prevents the very serious loss from early leaf fall and second growth as well as spotted or cracked fruit. In the nursery spray 5 or 6 times at 2 week intervals as long as young leaves are forming.

SCAB *(Venturia pirnia)*. Appearance and treatment about as in apple scab.

LEAF-SPOT *(Septoria pirina), Crown-gall, Rust, etc.,* also occur.

INSECTS.

TWIG GIRDLER *(Oncideres cingulatus)*. Adult eats twigs so winds break them off; larvae undergo transformations in fallen twigs. Burn fallen twigs.

SAN JOSE SCALE *(Aspidiotus perniciosus)*. See apple.

PEAR PSYLLA *(Psylla pyri)*. Injures by sucking. Apply kerosene emulsion.

PEAR SLUG *(Eriocampoides limacina)*. Injures by eating foliage. Apply arsenical or air slaked lime.

PEAR-LEAF BLISTER *(Eriophyes pyri)*. Mite injures leaves. Apply 10 per cent. kerosene emulsion while trees are dormant.

SCURFY SCALE *(Chionaspis furfura)*. See apple.

PEPPER.

ANTHRACNOSE *(Colletotrichum nigrum* and *Gloeosporium piperatum),* causes decayed, slightly sunken spots in the red pepper fruits. Spray with Bordeaux mixture.

PLUM.

DISEASES.

BLACK-KNOT *(Plowrightia morbosa).* Large black swellings on twigs. (Figure 30). Especially destructive to damsons, also occurs on cherry, especially the wild black cherry. Cut out and burn the knots in autumn, cutting four or five inches below the knot Cut out

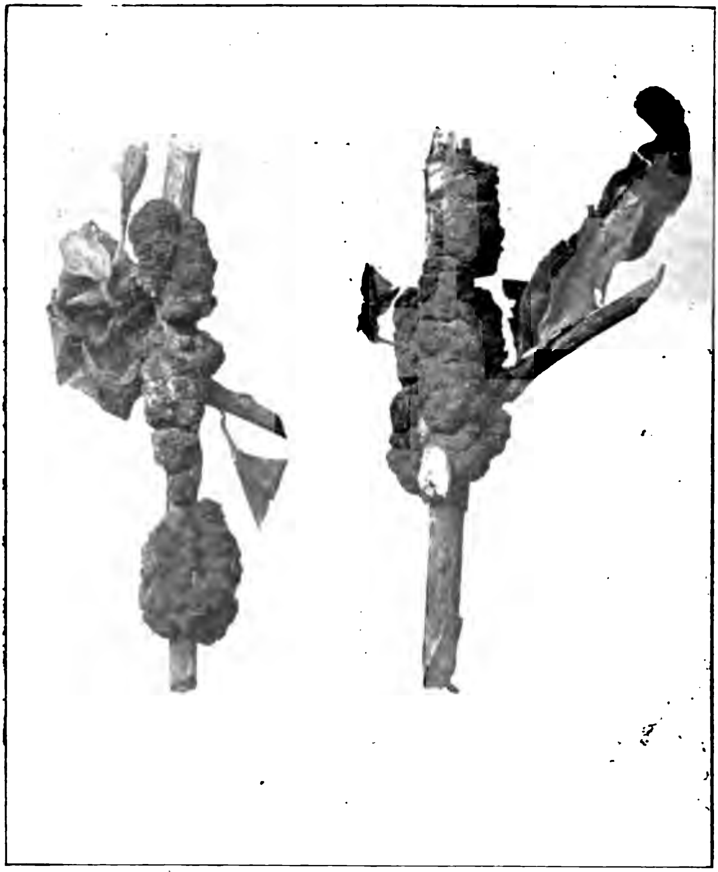

Fig. 30—Black-knot on plum.

new knots as they appear in summer on young branches. If very bad spray with Bordeaux mixture when buds begin to swell and repeat with peach Bordeaux mixture in two weeks.

CANKER. Sunken spots or knots extending through the wood on one side of branches. The branches may break off at the injured portion. Examine nursery stock and discard affected trees. Cut off and burn cankered branches in the orchard.

LEAF-BLIGHT OR SHOT-HOLE *(Cylindrosporium padi).* Treat as in cherry but use peach Bordeaux mixture.

PLUM-POCKETS *(Exoascus pruni)* causes bladdery distorted fruit. One may spray as for peach leaf curl but fungus may live over in the twigs.

INSECTS.

PEACH-TREE BORER *(Sanninoidea exitiosa).* See peach.

SAN JOSE SCALE *(Aspidiotus perniciosus).* See apple.

HOP-VINE LOUSE *(Phorodon humuli).* Plant louse, injures by sucking. Apply kerosene emulsion 15 per cent.

PLUM CURCULIO *(Conotrachelus nenuphar)* (Figure 31). See apple.

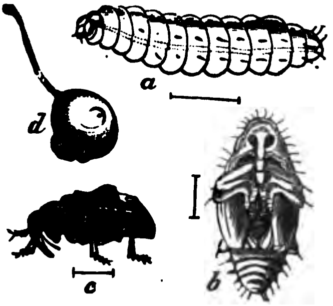

Fig. 31—The Plum Curculio; a, larva, b, pupa; c, adult; d, crescent-shaped slit on fruit. (After Riley.)

POPLAR, CAROLINA.

ANTHRACNOSE *(Marsonia populi).* One of the characteristics of this tree, often planted along streets for shade and ornament, is the early fall of the leaves due to this fungus. Spraying the portions of the tree in reach with Bordeaux mixture in June and July is recommended.

POTATOES, IRISH.

DISEASES.

EARLY-BLIGHT *(Alternaria solani).* Brown spots with faint rings in them on the leaves. (Figure 32). These gradually cover the leaf killing it. Spray with Bordeaux mixture, spraying three times between June 15, and digging time in the fall. The McCormick potato is not much troubled with this disease.

LATE-BLIGHT *(Phytophthora infestans)*. In moist summer weather, appears suddenly as soft, bad smelling, dark areas in the leaves and may kill whole fields in a short time. It is not common in this state. Treatment for this disease same as for early blight. The affected tubers may rot.

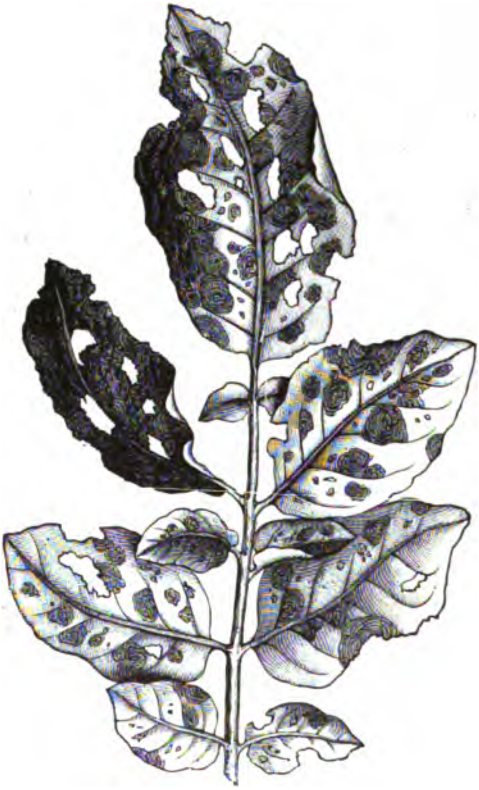

Fig. 32—Early blight of potato. (From Galloway, Farmers' Bulletin 91, U. S. Dept. Agriculture.)

BROWN-ROT *(Bacillus solanacearum)*. The leaves and stem wilt and shrivel and the tubers later show a wet rot. Thorough spraying with Bordeaux mixture and arsenicals to keep down insects which carry the germs. Do not plant on land which has recently borne potatoes, tomatoes or egg plant, all of which are subject to the disease. Store potatoes in cool, dark places.

DRY-ROT *(Fusarium oxysporum)*. Lighter colored and more or less rolled up leaves. The tubers later may be destroyed at least at one end by dry rot. Avoid infected soil and do not plant tubers that have internal brown or black streaks.

Scab *(Oospora scabies).* Scabby spots on the tubers. (Figure 33.) Soak uncut seed tubers in formalin, one-half pint to fifteen gallons water, for two hours and plant on scab free land. Avoid use of alkaline fertilizers. Scab resistant varieties are on the market.

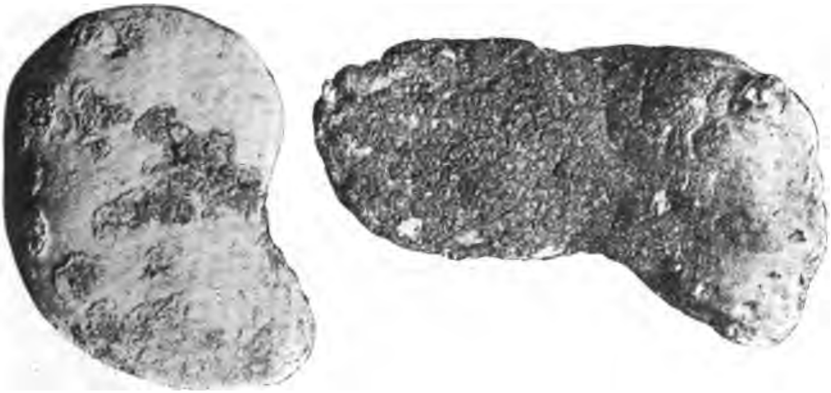

Fig. 33—Potato Scab.

For further information on potato diseases see Bulletin 108, of the Maryland Agricultural Experiment Station, in which several less important diseases are treated.

Insects.

Potato stalk-weevil *(Trichobaris trinotata).* Larva bores into stalk or branches. (Figure 34). Burn old vines. Clean culture.

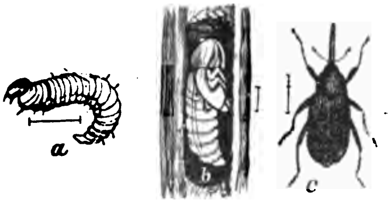

Fig. 34—The Potato Stalk Weevil; a, larva; b, pupa; c, adult beetle. (After Riley.)

Colorado potato beetle *(Leptinotarsa decemlineata).* Beetles eat foliage. Apply arsenical.

Blister beetle *(Epicauta vittata, Macrobasis unicolor).* Beetle eats foliage. Apply arsenical. Drive from patches with a brush into a heap of straw and then burn.

QUINCE.

The quince is subject to much the same diseases and insects as pear and apple, which see for treatment. It is especially liable to injury by the *Black-rot, Blight, Rust* and *Leaf-spot,* which, together, almost destroy the quince crop annually. They could be easily prevented by a little trouble in spraying and cutting out blight and black rot injuries.

RADISH.

The radish is subject to most of the diseases found in cabbage, but is rarely seriously injured by them.

RASPBERRY.

ANTHRACNOSE *(Gloeosporium venetum)*. White scabby spots on the young canes and on leaves so that they are unable to ripen fruit properly. Spray with Bordeaux mixture before leaves open and twice afterward with a weaker mixture. Cut out badly diseased canes. Also occurs on blackberry.

RUST *(Gymnoconia interstitialis)*. The leaves become bright orange color from the coating of spores of the fungus and the whole plant is seriously injured. Dig up and burn the diseased plants as soon as the yellow color begins to appear. Also occurs on blackberry.

CROWN-GALL. Large knots on the roots, causing poor growth and death of the canes. Dig and burn and replant on new ground with healthy stock. The disease also occurs on peach and some plums.

LEAF-SPOT. See blackberry.

For insects see blackberry and dewberry.

ROSE.

DISEASES.

POWDERY MILDEW *(Sphaerotheca pannosa)*. The leaves are somewhat wrinkled or curled and covered with a whitish powder. Troublesome in greenhouses when there is uneven temperature. It is bad on some varieties especially the Ramblers outdoors. Dust with sulphur outdoors or spray with Bordeaux mixture. Inside observe proper regulation of heat and spread sulphur paste on heating pipes.

LEAF-BLOTCH *(Actinonema rosea)*. Radiating black patches appear on the leaves and soon cause them to drop. Spray with Bordeaux mixture or one of the clear fungicides in midsummer.

RUST, LEAF-SPOT AND ANTHRACNOSE are less troublesome.

INSECTS.

ROSE SCALE *(Aulacaspis rosae)*. Injuries by sucking. Apply strong soap solution. Cut out badly infested branches.

PLANT LICE *(Aphis sp.)*. Injure by sucking; apply 10 per cent. kerosene emulsion.

ROSE CHAFER *(Macrodactylus subspinosus)*. See grape.

RYE.

RUST and SMUT are about the same as on wheat.

SORGHUM.

SMUT of the grain and BACTERIAL BLIGHT, causing reddish, diseased patches on leaves and stalks, have not yet been found serious in Maryland.

SQUASH.

SQUASH-VINE BORER *(Melittia satyriniformis).* Larvae bore into squash-vine. Cut pest out of wilting vines. Grow a summer variety as a trap crop to protect the late varieties.

STRIPED CUCUMBER-BEETLE *(Diabrotica vittata).* See cucumber.

SQUASH LADYBIRD *(Epilachna borealis).* See cucumber.

COMMON SQUASH-BUG *(Anasa tristis).* See cucumber.

The squash is subject to much the same diseases as melons and cucumbers.

STRAWBERRY.

DISEASES.

LEAF-SPOT *(Sphaerella fragariae),* erroneously called *rust.* Small brown spots surrounded with a reddish ring on the leaves. Some other fungi also cause spots on strawberry. All are controlled by burning over the patch in autumn or winter. Spraying with Bordeaux mixture before blossoming and after fruit is picked is helpful. Some varieties, as Gandy, are more injured by the disease.

POWDERY MILDEW *(Sphaerotheca castagnei).* Somewhat wrinkled and white mildewed leaves, usually not abundant. Spray with Bordeaux mixture or dust with sulphur.

INSECTS.

STRAWBERRY ROOT-LOUSE *(Aphis forbesi).* Burn off patches in late winter, thus destroying the eggs. Cultural methods.

WHITE GRUB *(Lachnosterna arcuata)* Larvae eat roots of plant, Rotation of crops. Apply salty fertilizers.

STRAWBERRY WEEVIL *(Anthonomus signatus).* Beetles cut off buds in which eggs are laid. Grow resistant varieties. Clean culture.

STRAWBERRY LEAF-ROLLER. *(Ancylis comptana),* Injures foliage. Destroy old beds in fall. Spray early in spring with arsenical.

SWEET POTATO.

DISEASES.

BLACK-ROT *(Ceratocystis fimbriata).* A black decay of the potato and black spots or streaks on the young slips or vines. (Figures 35, 36). Keep the beds from contact with affected potatoes and use for slips only those perfectly free from the disease. Do not plant any slips that show any sign of the *"black shank."*

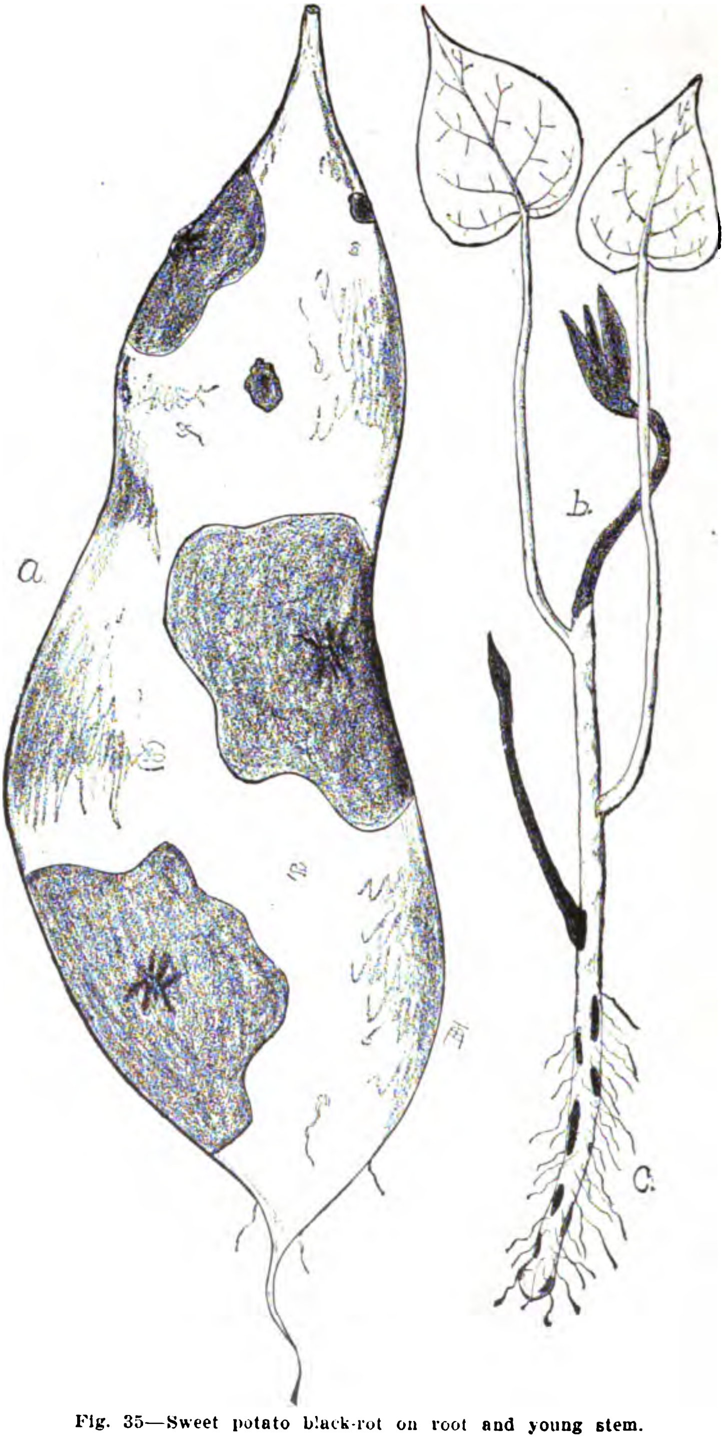

Fig. 35—Sweet potato black-rot on root and young stem.

ROT of several kinds occurs in storage and is prevented by careful attention to storage conditions, proper temperature, dryness, discarding decayed potatoes, etc.

INSECTS.

CUT WORMS (various species). Injure by cutting and eating stem. Fall plowing, poison baits on land just before crop is planted.

SWEET-POTATO FLEA-BEETLE *(Chaetocnema confinis)* Adult beetles eat channels in leaves. Apply arsenical with Bordeaux mixture. The latter is distasteful to the insect.

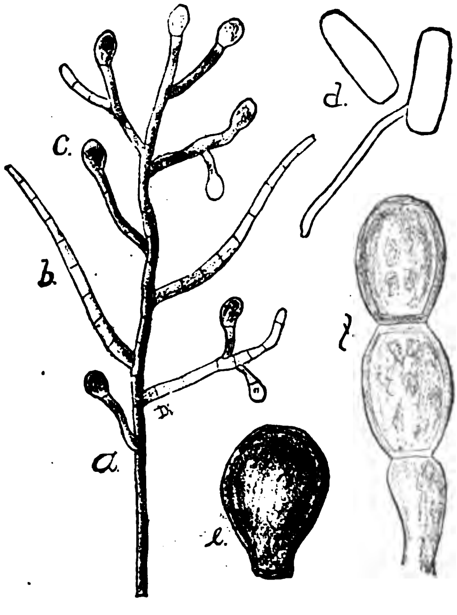

Fig. 36—Fungus causing black-rot of sweet potato; highly magnified.

GOLDEN TORTOISE BEETLE *(Coptocycla bicolor).* Injures foliage by eating. Apply arsenical with Bordeaux mixture.

TWO-STRIPED TORTOISE BEETLE *(Cassida bivittata).* Same as preceding species.

CUCUMBER FLEA-BEETLE *(Epitrix cucumeris).* See cucumber.

SYCAMORE.

ANTHRACNOSE *(Gloeosporium nervisequum)* or blight. The leaves and young twigs are killed in early summer. Bordeaux mixture just before the leaves appear would be effective when practicable.

TOBACCO.

DISEASES.

MOSAIC DISEASE, FRENCHING. The leaves have a mottled appearance and are more or less wrinkled or curled. The disease is easily transmitted from one plant to another and can be communicated by handling in any way the growing plants. Diseased plants should be destroyed especially in the bed.

ROOT ROT, DAMPING-OFF and other diseases that sometimes injure the young plants in the bed can be largely controlled by using entirely new beds each year, or sterilizing them by burning or otherwise.

Such troubles of the curing house as *pole burn, stem rot,* etc., might be helped considerably by disinfecting the houses before putting in the tobacco by spraying the inside of the house, poles, etc., with formalin solution as used for potato scab; and removing and burning diseased stems.

INSECTS.

TOBACCO FLEA-BEETLE *(Epitrix parvula).* Larvae injure roots, beetles feed on leaves. Apply arsenical.

CUCUMBER FLEA-BEETLE *(Epitrix cucumeris).* See cucumber.

NORTHERN TOBACCO WORM *(Phlegethontius quinquemaculata).* SOUTHERN TOBACCO WORM, HORNBLOWER *(Phlegethontius sexta).* Larvae eat foliage of plant. Apply arsenical. Hand picking. Turkeys in the tobacco fields will aid in controlling the pest.

CIGARETTE BEETLE *(Lasioderma testaceum).* Insect eats small holes in the finished products, cigarettes or cigars; also in cured leaves, etc.. Fumigate with carbon bi-sulphide or hydrocyanic acid gas.

TOMATO.

DISEASES.

LEAF-SPOT OR LEAF-BLIGHT *(Septoria lycopersici).* Small spots on the lower leaves which die finally, leaving only the upper young leaves to bear all the burden of maturing fruit. Very destructive. Spray the plants with Bordeaux mixture and dip the leaves in it before planting. Give about three sprayings in the field, the first, two or three weeks after the plants are set, and the last just before the fruit is grown. Early sprayings in the bed are very helpful.

SOUTHERN BLIGHT *(Bacillus solanacearum).* The plants wilt and show black streaks in the stem. This is the same as the brown-rot of the potato and has similar treatment.

LEAF-MOLD OR SCAB *(Cladosporium fulvum).* Greenish brown patches on the underside of the leaves. It is especially troublesome on tomatoes grown in the greenhouse. Spray thoroughly and frequently with Bordeaux mixture.

ROT. There are several rots of tomatoes, due to different causes. The point-rot, troublesome in the greenhouse, is due to lack of sufficient water. The bacterial rot in the field can be controlled to some extent by removing the rotten tomatoes as they appear, and by spraying with Bordeaux mixture and arsenicals to keep down insects.

INSECTS.

FLEA BEETLES, mentioned under cucumber, sweet potato and tobacco, attack this plant.

NORTHERN TOBACCO WORM, TOMATO WORM *(Phlegethontius quinquemaculata)*; SOUTHERN TOBACCO WORM *(Phlegethontius sexta)*. See tobacco.

TOMATO FRUIT WORM *(Heliothis obscura)*. Larva bores into fruit. Fall plowing; clean cultivation; corn as trap crop.

TREES.

Timber and shade trees, in addition to many leaf diseases, are attacked by numerous fungi that grow in the wood and cause decay. Some even grow in live wood and kill it. The mushrooms or shelf fungi, seen growing from logs or from dead portions of live trees, are the fruiting organs of these wood destroying fungi; the larger part of the fungus lives in the decayed part of the wood.

Much can be done to protect shade trees by destroying all dead portions and the fruiting bodies of the fungi and painting over injuries. To some extent this can also be practiced in well regulated forests. At least dead and mature trees should be cut and used. There are various methods of protecting cut lumber of all kinds from decay, but this is hardly the place to discuss them.

Illuminating gas escaping in the ground often kills trees on city streets, and the gases of smoke in manufacturing regions seriously injure many kinds of trees, especially the evergreens, like pine and spruce.

Injuries by horses hitched to trees and by unscrupulous wire stringers, unfortunately, are too common.

There are many common pests which attack our forest and shade trees, the majority being insects that do injury by eating the foliage, in which case the stomach poison or arsenical is employed to control their ravages. There are also many scale insects that attack these plants which can be controlled by one of the contact insecticides. The oyster shell scale is doing considerable injury to the maple trees in many parts of the state. We refer the reader to Bulletin 111 of this Station for further information concerning this pest.

TURNIP.

The turnip is subject to much the same diseases and insects as cabbage. Usually none are serious.

VIOLET.

LEAF-SPOT *(Alternaria violae)*. Circular brown spots on the leaves. This and other violet diseases can best be controlled by growing only the strongest and healthiest plants that can be secured and keeping them under the best condition throughout the year, removing or burning all diseased parts and disinfecting the houses and beds.

BLACK OR BROWN APHIS *(Rhopalosiphum violae)*. Plant louse; sucks leaves. Fumigate with hydrocyanic acid gas. Seek further advice before using.

TWO-SPOTTED RED SPIDER *(Tetranychus bimaculatus)*. See geranium.

WALNUT.

YELLOWS. A disease somewhat like peach yellows, often causes bunches of slender yellowish shoots on the walnut, especially on Japanese varieties. So far, it has not proved very destructive, but is not yet well known.

WATERMELON.

The diseases are about the same as other plants of this family, such as muskmelon and cucumber. The anthracnose is the main trouble and can be controlled by a few sprayings with Bordeaux mixture. For insects see cantaloupe.

WHEAT.

DISEASES.

RUST *(species of Puccinia)*. Reddish or black rusty specks or streaks often covering the leaves and stem. On badly rusted wheat the grain is shrunken and light. The only promise of control is in rust resistant varieties. Some have been secured for the western wheat regions, but none yet very good for this section.

SCAB *(Fusarium culmorum)*. The central stem of the head is killed by wet weather and the fungus and the upper part dies. The fungus appears as pink or black spots on the stem or chaff. No remedy.

LOOSE SMUT *(Ustilago tritici)*. The head is changed into a black, dusty mass. Soak the seed four hours in cold water, let stand four hours in wet sacks and then immerse for five minutes in hot water. (113 degrees F.). Then dry and sow. This is only a partial preventive and may cause some injury to the seed. If possible, sow seed from smut-free fields.

BUNT OR STINKING SMUT *(Tilletia tritici)*. The injury is to the grain only which is swollen and filled with a black stinking substance, which ruins the flour if abundant. Sprinkle the pile of grain to be sown with formalin (1 part to 400 of water) until all the grain is wet, let it stand two or three hours, then dry and sow.

INSECTS.

WHEAT JOINT-WORM *(Isosoma grande)*. Larva works at joints in stem. (Fig. 37.) Plow down or burn off stubble.

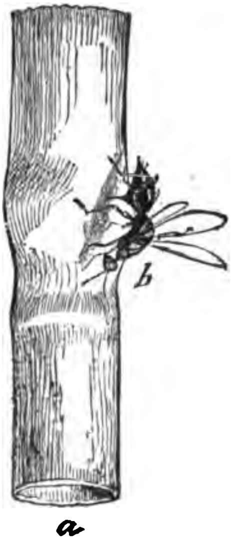

Fig. 37—The Greater Wheat Joint-worm. Female ovipositing in wheat-straw. (After Riley.)

WHEAT LOUSE *(Nectarophora avenae)*. No practical remedy. Natural parasite (Fig. 38) usually. Ten per cent. kerosene emulsion would control pest if possible to use.

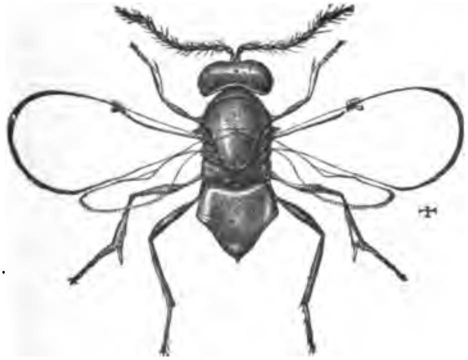

Fig. 38—Parasite of the Grain Plant-Louse. (After Howard.)

HESSIAN FLY *(Mayetiola destructor)*. Larvæ injure stem of plant. Plow or burn stubble. Sow wheat late in fall, after frost.

NOTICE.

If further information is desired about any insect write to the Entomologist, College Park, Maryland; or, if information is desired concerning any disease of plants, write to the Pathologist, College Park, Maryland. If the insect or cause of the disease is not known, samples can be mailed to the above address for identification. Information is furnished free of charge.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 116. MARCH, 1907.

MARKETING FRUIT AND TRUCK CROPS.*

BY W. N. HUTT.

INTRODUCTION.

The most obvious development of mercantile methods in the last decade is seen in the preparation of products for market. With pristine merchants, tea was tea and soap was soap. They bought in bulk and measured or weighed out the quantities desired by their customers. The goods came in barrels and hogsheads and went home in the various baskets and boxes of the purchasers. With the merchant of today the bulk article is almost unknown. His shelves, cellars and refrigerators are stored with divers small cans and boxes and packages under numberless labels and trade-marks, each containing a definite amount of some varied commodity of home consumption. Times have changed, so have men and methods. The recent Pure Food Law is an evidence of the approaching millennium.

Modern commercialism offers no more interesting phase than the almost infinite modifications and numberless varieties of the few staple necessities of human consumption. Indeed, nowadays, one would be much surprised if at breakfast he were not served with some new variety of breakfast food of magic muscle and brain-building power. There is no better example of man's inventive genius than the kaleidoscopic variety of his food products.

The marketing of horticultural products has followed pretty closely along the same mercantile lines as general food products. New types and varieties of native fruits have of late years largely increased. Extended communications by land and water bring to even our local markets the varied horticultural products of the whole world. New and strange fruits are seen in our stores almost daily. One may breakfast on fruit of the orient, dine on products of the antipodes and sup on salads of the occident. All these are brought to our doors by recent improved methods and facilities in transportation and marketing.

While horticultural products have largely increased in quantity and number, the containing crates and shipping packages have by modern requirements been largely unified and reduced to definite standards. The peculiar heterogeneous baskets and boxes and crates that used to carry fruit to market are scarcely ever seen today. Their places have been taken by a few standard packages. As with general merchandise, the bulk method of marketing horticultural products has almost entirely disappeared. Greater quantities of fruit, than ever before, are now marketed but they go to market in much smaller packages than formerly. With tender fruit of high quality the hogshead and barrel package has almost disappeared from our markets. With even hard, winter apples the bushel box is rapidly displacing the larger barrel. Strawberries used to be shipped in 56 and 60-quart crates but now the best kind of berries in such a carrier would go begging for a customer. Plums, peaches and grapes are now sold in packages much smaller than those formerly used. This decreasing of the size of the package in which fruit is sold has enormously increased the consumption of fruit with all classes of people. Many who could not afford a barrel will readily buy a box or basket, especially since the box or basket is light and portable and does not need to be returned. Thus the gift package in selling fruit has become almost universal and being made of very light wood or veneer it costs comparatively little to the grower. There seems to be an increasing tendency in the fruit trade to sell fruit in packages that a man can take home in the hand.

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* The data for this bulletin was collected previous to Professor Hutt's resignation, October 1st 1906 to accept a position at the North Carolina Experiment Station, but the manuscript was not turned in until March 1907. H. J. P.

BRANDS AND TRADE-MARKS.

The use of trade-marks and labels is not entirely a modern practice; it had its origin in the past but this is its golden age. A trademark is a sign of honesty. The man who stamps his goods with his own name, or business crest, shows that he is not ashamed of them and the purchaser feels it a sort of guarantee of quality. True, there are spurious trade-marks glued on with intended deception, but the counterfeit only more surely proves the reality of the current coin of the realm. In spite of the questionable methods of some modern merchants who make undue haste to be rich, the world is getting better and modern business methods are purer and better than ever before. The recent Pure Food Law will doubtless be instrumental in purifying our food products and in eliminating dishonest brands and trademarks.

Many old trade-marks in use today have come down to us through the centuries, to mark the honesty of their originators. The word "Sterling" which today marks the purity of our silver was the name of a firm of Flemish merchants, the Sterlings, who were noted for the purity of their money in an age when debased coin was notoriously common.

Horticultural products have always been noted for their purity. Many careful growers of fruit have worked up a special fruit trade by shipping high-class fruit under their own brand and name. In years when climatic and other conditions render the quality of fruit lower than the grade they are accustomed to ship under their named brands, the fruit is forwarded unbranded. A neat attractive brand or label on well-packed fruit soon becomes known and asked for on the market.

A brand should include besides the name and address of the grower, the variety of fruit contained in the package. The general trade brand can be kept in stencil form for head of barrel or box with an insert to show the variety. With basket fruit, like peaches or grapes, the variety name may be put on clearly with a rubber stamp. If the variety is good the customer often wants to know the name of it so that he can get more of the same kind. The best goods in commercial lines are sold under brands containing the name, location and trade-mark of the maker. It is a business principle that the buying public soon comes to understand. They know that if a man puts his name and address on his produce he is not ashamed of its quality and it is safe to buy such produce. The best growers and shippers of fruit today are making use of this same business principle. I do not believe there is a more important factor in successful fruit-growing than the proper packing and labeling of fruit.

THE RETAIL FRUIT TRADE.

It is safe to say that of the numberless cars and cargoes of fruit that go to market by far the largest part of it goes to the consumer through the hands of the Italian fruit vender. He takes to the retail fruit trade by nature as a Chinaman does to laundry work or a duck to water. His education and temperament adapt him to the fruit stall or push cart just as naturally as fins fit a fish for its native element. One cannot board a railroad train or steamboat but he must pass the alluring wares of the "Dago" fruit vender. In this apparently small way the products of millions of vines and fruit trees find their way to a profitable market. There are thousands of these Italian stall venders and push cart men in our large cities and they are rapidly finding their way to and establishing themselves in our large towns. His stall or cart is the final clearing house for the fruit trade and shippers who would be successful must reckon with the requirements of this king of the market.

The "Dago" vender is very rigid in his requirements of the fruit he will buy. He knows that fruit sells on its appearance and will buy nothing that does not look attractive and therefore salable. He wants only the freshest of fruit or that which will stand up well and give him plenty of time to sell it before it becomes soft. He wants perfect fruits of uniform grade, for he will not have culls or small, defective specimens left on his hands at a loss. He deals most largely in bananas, oranges and the firm, dry, highly-colored fruits of the Pacific Coast for they conform most closely to his requirements. The Italian vender is such a powerful factor in the fruit trade that his requirements are not to be disregarded. Shippers and growers can well afford to consider his standards.

As in most cases the grower of fruit cannot carry his fruit to the consumer, he must employ the railroads to ship it for him and the commission merchants to sell it on its arrival in the city. Very often these three parties are a triumvirate of discontent. My observations lead me to believe that it is because they know too little of each other's methods, but each maintains that it is because he knows too much of them. Each has at any rate an interest in the business that is well worthy of investigation.

RAILROADS IN RELATION TO HORTICULTURE.

The railroads have always been the scapegoat from both sides of the business, and I cannot refrain from saying a word in their favor, even though they are pretty well able to take care of themselves. Following the pioneers of commerce, railroads have been the most active agents in the developing of the country; greater than armies and navies, greater perhaps than our universities. With most of the great railway corporations their interest in horticulture is more than a passive one. Many railroads are paying trained horticultural experts to develop the fruit and truck raising along their lines. Only this summer I lost a valuable assistant because the railroad could afford to pay him more for horticultural work than the State could. They are doubtless looking after their own interests, but they pay men to help the grower to help himself. It is very easy for the grower to throw the blame for his lack of success on the railroads or on the commission men. Undoubtedly the railroad people and the commission men are not all good, as are the growers not all good, but at any rate I believe they are human.

DISHONEST PACKING.

Some growers and packers of fruit are really very unfortunate, for nature herself seems to be against them. On some farms the laws of gravitation seem to be reversed and the large fine apples gravitate to the ends of the barrel, and the little, gnarly ones gravitate to the middle. Such men are unfortunate, for it is of them that the Scripture says, "They are like the chaff that the wind driveth away." But there are many honest growers who take good care of their orchards and spray well and pack honestly that are unsuccessful because they do not know the market and its requirements.

MARKET PROBLEMS.

Let us look at some of the market's problems. First in importance is what market to send to, when to send to it and what to send to it. Some markets will take a product that others will not have. For example, Porter apples will sell well in Boston but are not wanted in New York. Tolman (Sweets) bring good prices in Philadelphia but can scarcely be given away in Rochester. Some people think brown eggs are richer than white eggs. Some markets will buy only white-skinned poultry while others want only yellow-skinned. Some consumers believe red apples are of higher quality than those of other colors. A grocer in a certain city told me that that was a black tea town and that one could not get the people there to use Japan tea if one gave it to them. He was a wise merchant and kept only black tea and did not try to make his customers take what they did not want. It is hard to educate public taste. It always pays the fruit grower to study the demands of the market and to give people the kind of fruit they want.

When to send to a certain market is a still more difficult question than what to send. The wind itself is scarcely more fluctuating than market prices. You see in today's paper that there is a shortage of fruit in a certain market, you send there heavily expecting to find a good market, everybody else does the same, and tomorrow sees a glut in that market with slaughter prices. Such a glut occurred in New York market last summer with vegetables and the stuff could scarcely be given away by the commission men. The only safe way to watch the market is to have one's finger on the wire.

The growing of good fruit is of course fundamental to the selling of good fruit. Formerly, growing and selling were all one business. In the early days, the farmer raised his fruit with little molestation from insects and fungi, placed it in his wagon and took it to market to his customers. The business was soon over and he came home with necessary supplies obtained in barter for his fruit. But "the good old days" are past, and now to have any fruit at all the grower must give earnest and intelligent attention to the insect and fungi sides of the business. These are homonymous and also synonymous with insecticide and fungicide. Indeed, nowadays the successful fruit-grower has become, under the instructions of Colleges and Experiment Stations, a practical entomologist and pathologist. He finds that unless he knows the habits of insects and of fungous diseases and also the means of checking or averting their attacks he is in a losing business. He cannot take his fruit to market as formerly for the centers of population have moved far from the farm or vice versa, so he must consider the packing, shipping and marketing sides of the business.

Too often the grower of fruit sends his produce by an unknown route, to an unknown people, in an unknown market. The result is well known, for it becomes a frequent topic of conversation with neighbors how he is cheated by the railroads and the dishonest commission men in the city. Often the farmer packs his fruit as well as he knows, often too, not as well as he knows, but without a knowledge of the market and its requirements he seldom gets a first-class price.

Marketing is almost a science in itself. Many farmers can grow fruit while but few can market it successfully. One can learn many valuable things about markets from shrewd observations from the outside, but to really know the selling business one must look at it from the inside. Few growers have the opportunity to look on the market business from the inside therefore they have many painful experiences. Experience is a very good but also a very expensive teacher. One of the most successful fruit growers I know of makes annual trips to the large cities to look into market conditions. Heretofore the trained experts of Agricultural Colleges and Experiment Stations have given nearly all their attention to the problems of the growing of fruit to the almost entire disregard of the market side of the business. Growers often tell me that they can raise good fruit but they often fail to market it profitably. Some growers claim that there is an over-production of fruit. What they call over-production is really want of distribution, for there can be no absolute over-production while there are people hungry for fruit and ready to pay for it.

COMMISSION MERCHANTS.

Most of the general fruit that goes to market is sold by commission merchants. These merchants receive the fruit consigned to them, and on selling it charge the consignor usually 10% of the selling price and remit the balance less charges for freight, drayage, &c. Properly handled, this method of marketing fruit gives very good results. I know of a case where a fruit-grower has sent all his fruit to one commission man for the last twenty-one years to the mutual benefit of both. After this long-standing business relation of fruit-grower and commission man each respects the other. But such a case is the exception rather than the rule. One too often hears the commission man spoken of by the fruit-grower as a rascal, while the commission man regards the farmer as a most shiftless business man. There is much to be said on both sides, but it may safely be said that selling by commission is a loose method of business when regarded from the interests of the consignor. In the first place the commission man bears no risk, as the fruit is the property of the consignor till sold and the latter carries all risk and bears all losses. The commission man has usually little or nothing invested in stores or warehouses for his consignor's fruit. Often he sells the fruit by auction or private sale from wharves or railway platforms in which he has not a cent's worth of interest, or uses the public streets and pavement before his small shop. The sender of the fruit has only the commission merchant's word for the price at which his fruit or truck sold. This is certainly a loose method of business and gives great opportunity for fraud and has often been taken advantage of by dishonest merchants. This fact has branded the whole commission fraternity as "Thieves and robbers." However, honest merchants by their commission leagues and societies have found means of shutting out dishonest men from the business, yet it is easy to see that the advantages of commission selling are largely in favor of the consignee rather than of the consignor.

A great deal of the adverse criticism and even opprobrium that is cast upon commission merchants for small returns is often due to the growers' carelessness, lack of business ability or lack of knowledge of market conditions. Let us take these up separately.

GRADING FRUIT.

CARELESSNESS IN PREPARING FRUIT AND TRUCK PRODUCTS FOR MARKET.

To see the way in which some fruit comes to market one would not wonder that there are farmers who say fruit growing does not pay. Not infrequently baskets give evidence from their blackened, mouldy appearance that they have been stored in damp cellars or they show the chaff and dust of the hay loft. Such packages could not bring a good price for even the choicest of fruit. Second-hand packages or those that have been used for fruit before, besides being unsightly, will cause fruit to decay on the road to market. The wood of second-hand packages becomes impregnated with the spores of moulds and rots from former fruit and will cause the speedy decay of fresh fruit coming in contact with it.

Not infrequently packages are used which are unsuited to the nature of the fruit. A bushel basket is a poor means for carrying and displaying delicate, high-class fruit like peaches. A barrel is too large for soft fruit like Bartlett and Clapp pears. Often a 20-lb. basket of grapes will be begging for a purchaser while if the same fruit were placed in dainty 3-lb. baskets the fruit would sell like hot cakes at 25 and 30 cents a piece, or 8c. to 10c. per lb. for the grapes.

The most common evidence of carelessness on the part of the fruit-grower is the sending of ungraded products to market. An ungraded package showing large, intermediate and small specimens of fruit almost invariably sells at the rate paid for inferior stuff. It would probably sell at a better price if every specimen in the package were small, the large specimens being a detriment rather than otherwise. It is a frequent sight in the commission houses of any of our large cities to see men sorting and repacking fruit carelessly put up by the farmer. The commission men pays the farmer a minimum price for the whole package, and that is the best that can be gotten for it. The large fine specimens are sorted out and packed in a smaller package and bring a special price, often much greater than could be gotten for the whole original ungraded package. The profit for such grading which might have gone to the grower, naturally went to the commission merchant who did the work. The farmer, moreover, paid the same freight on the inferior fruit in the package that he did on the special grade that brought the special price to the commission merchant. Figure 1 shows a good type of machine grader. This greatly reduces the labor and cost of grading. Defective specimens are removed from the graded fruit as it is put into the packages.

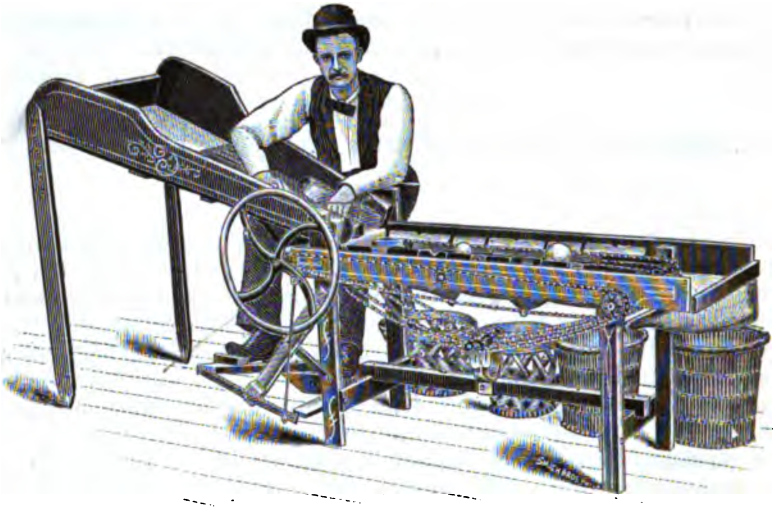


Figure 1—Machine Grader.

Selling fruit is a very different business from the growing of it. There are a great many more men who can successfully grow fruit than there are who can profitably market it. The marketing of fruit is a special business by itself. The successful production of fruit requires knowledge of growing conditions; the profitable marketing of it requires knowledge of selling conditions. Few men are able or are in position to know thoroughly both ends of the business, thus the need of the commission man.

Some commission men even take the trouble and expense of sending an advance market sheet to advise their clients of the state of the market. The following is quoted from one of these reports:

MARKET REPORT.

Buffalo, Thursday, August 24th, 1905.

APPLES AND PEARS.

Apples—Receipts are increasing, but the demand is active for anything above common and that class sells also at much higher prices than usual. In fact, so far apples of all kinds have brought more money than expected.

Red Astrachan, No. 1, per bbl.	2 50@3 00
Strawberry, do	2 75@3 00
Duchess, do	3 00@3 50
Sweet Bough, do., fancy	2 75@3 00
Golden Sweet, do	2 25@2 50
Common, green, per bbl	1 50@2 00
New York State, fancy 1-3 bu.	45@ 50
New York State, fair to good	30@ 40
New York State, per bu	50@1 25
Crab Apples, per basket	15@ 20

PEARS—Some good pears are beginning to arrive and there will be no difficulty in disposing of choice to fancy around quotations. Bartletts and other varieties in dinky measure boxes are not in favor in this market, and especially at the high prices at which this rather inferior fruit is being held.

Pears, Bell, per bbl.	1 75@2 00
Pears, Sugar, per bbl	2 00@2 25
Pears, Bartletts, per bbl	3 50@4 00
Pears, Clapp's F., per bbl.	3 00@3 25
Pears, Tyson, per bbl.	2 50@2 75
Pears, Clapps, F., 8-lb. basket	20@ 25

PEACHES.

The first really fancy peaches in several weeks arrived yesterday from Michigan and selections brought the highest prices in years. Fancy fruit was badly wanted and all of that class cleaned up quickly. There were, however, only a few baskets above good in quality, but all cleaned up readily at much better prices than expected. Home-grown are in abundance and selling at such a wide range that it is impossible to quote the market. The glut of early fruit is the worst in years and it will take low prices to move it.

Ohio, peck basket	20@ 30
N. Y. State, small basket	15@ 20
N. Y. State, 1-3 basket	30@ 40
Michigan, yellow, fancy bu.	2 00@2 50
Michigan, white, per bu.	1 00@1 75
Michigan, fair to good, do	1 50@2 25

GRAPES.

Receipts are increasing and quality is greatly improved. The best lots sold readily at quotations, but there is quite a supply of common stuff still on the market.

Moor's Early, 8-basket carrier	1 00@1 25
Champion, 8-basket carrier	75@ 85
Niagara, 8-basket carrier	1 25@1 50
Hudson River, pony baskets	12@ 15

BERRIES.

HUCKLEBERRIES—Unsalable except at very low prices. Offerings are quite heavy, considering the slow trade, and the outlook is for still lower prices.

BLACKBERRIES—Early receipts clean up easily at good prices.

Blackberries, Lawtons per qt.	10@ 12
Blackberries, medium, per qt.	8@ 9
Blackberries, wild, per qt.	10@ 11
Huckleberries, per quart	5@ 7
Huckleberries, per 12-lb. basket	40@ 60

PLUMS.

Receipts were very heavy, dealers being swamped, and even at the low prices prevailing it was impossible to clean up the market. Next week there will be a cry for plums and buyers will probably pay a good price.

Plums, red, 7-lb. basket	10@ 12
Plums, yellow, do.,	10@ 12
Burbanks, per 7-lb. basket	10@ 12
Michigan, per 7-lb. basket	12@ 15
Niagara, per 7-lb. basket	12@12½

MELONS.

Muskmelons—It's the old story of poor quality. The expectation was some improvement in that respect, but even home-grown has shown up more than usually poor. The hope is that next week's receipts will change the general complaint.

Watermelons—Good steady trade for ripe, but there is only a moderate supply of that quality, and far more of the undesirable than can be sold at much above freight charges.

Muskmelons, fancy, ⅌ crate	1 50@1 75
Muskmelons, fair to good	50@1 00
Muskmelons, R. F. Stand., crate	5 00@5 25
Muskmelons, R. F. pony	4 00@4 50
Muskmelons, Ind., per basket	20@ 30
Muskmelons, H. G., per basket	40@ 50
Muskmelons, Osage, per bu.	1 50@1 75
Watermelons, large, ⅌ 100	22 00@25 00
Watermelons, medium, do	18 00@20 00
Watermelons, small do	14 00@16 00

POTATOES.

A slight scarcity, due to rain at outside shipping points, caused a stronger feeling here, but it was only momentarily, as there is a world of potatoes again this year, and the market is plentifully supplied today, with every prospect of prices going lower next week. Home-grown are of excellent quality, and will probably supply the demand in this section from now on.

Fancy, per bbl	1 75@1 80
Fair to good	1 50@1 60
Culls and common	75@1 25
Home-grown, fancy, per bu.	60@ 65
Home-grown, fair to good, do	50@ 60

Sweet Potatoes—Few offerings of desirable and inquiry active. Plenty of common to fair and small stuff which buyers do not want.

Sweet, Virginia, fancy, bbl.	2 25@2 30
Sweet Virginia, fair to good	1 50@1 75
Sweet, Jersey, fancy, ½-bbl.	1 50@1 75
Sweet, Jersey, No. 2, ½-bbl.	1 00@1 25

ONIONS.

Little interest at present; home-grown are coming in liberally and selling at quotations. Quality is only fair so far.

Onions, Spanish, per crate	1 10@
Onions, Ken., No. 1, per bbl	1 40½1 50
Onions, do., No. 2	1 00@1 25
Onions, H. G., per bu.	50@ 55

VEGETABLES.

Beans—Very irregular; shipping demand light and prices are lower.

Cucumbers—Pickles are wanted; little demand for large and supply liberal.

Cabbage—Market easier on steady, increasing receipts.

Celery—Weak; heavy supply.

Peppers—Lower; receipts excessive at the moment.

Eggplant—Irregular; some shipments worthless and plenty of fancy at low prices.

Squash—Liberal receipts; good demand.

Tomatoes—Market flooded with red at easy prices while pinks are scarce and wanted at a premium.

Beans, yellow, per bushel	35@ 40
Beans, green, do. do	40@ 50
Beans, shell, per qt	7@ 8
Beans, shell, Lima, per qt.	10@ 12
Cucumbers, fancy, per bu	40@ 50
Cucumber pickles, per 100	12@ 15
Cauliflower, per doz	1 25@1 50
Cabbage, fancy, per 100	2 50@3 00
Cabbage, small, medium, do	1 50@2 00
Celery, fancy, per doz.	30@ 35
Celery, fair to good	15@ 25
Celery, Kalamazoo, per doz	10@12½
Eggplant, per dozen	25@ 40
Peppers, per bbl.	50@ 60
Squash, marrow, per bu	40@ 50
Tomatoes, H. G., 8-lb. basket	8@ 10
Tomatoes, Acme, per bu.	75@ 90
Tomatoes, red, per bu.	30@ 40
Watercress, per doz. bunches	15@ 20

One can readily see the great value to the shipper of such a report sent from his commission man who is in touch with the latest market conditions. It has much more value than a general newspaper report. The brief, forceful notes in this report by the commission man on the quality of produce, should be eloquent to the grower who has produce to sell.

After a shipper has found a good reliable commission man in a certain market it generally pays better to send to that man exclusively rather than to divide consignments amongst different merchants in the same market.

THE NEW YORK FRUIT EXCHANGE.

The most up-to-date fruit selling association that I have ever seen is the New York Fruit Exchange which has its head office at 81 Beach St., New York City.

As a forwarding and selling association the New York Fruit Exchange is unique. From its head office it keeps track of all car and ship-loads of fruit from the time of loading till they are placed in any market. By means of a blanket rate a car of fruit from the west to New York may be diverted en route to Philadelphia, Pittsburg, St. Louis or elsewhere, wherever the market promises best. By telegraphic communication it is known several days or a week beforehand just when large consignments of any fruit may be expected to arrive and bulletins for the use of members are posted accordingly.

Small consignments of fruit are exposed and sold in the show rooms of the exchange. Large consignments are sold at the dock on arrival. The fruit is brought to the Erie Pier by boat-load or cars, run onto ferries, which unload from ships directly to the wharf. All fruit consigned to the exchange is received by its agents and placed on the wharf, and a few boxes of each opened for inspection. If a car is composed of mixed lots, each lot is placed by itself, and given a number. All the fruit consigned for the day is placed in position and

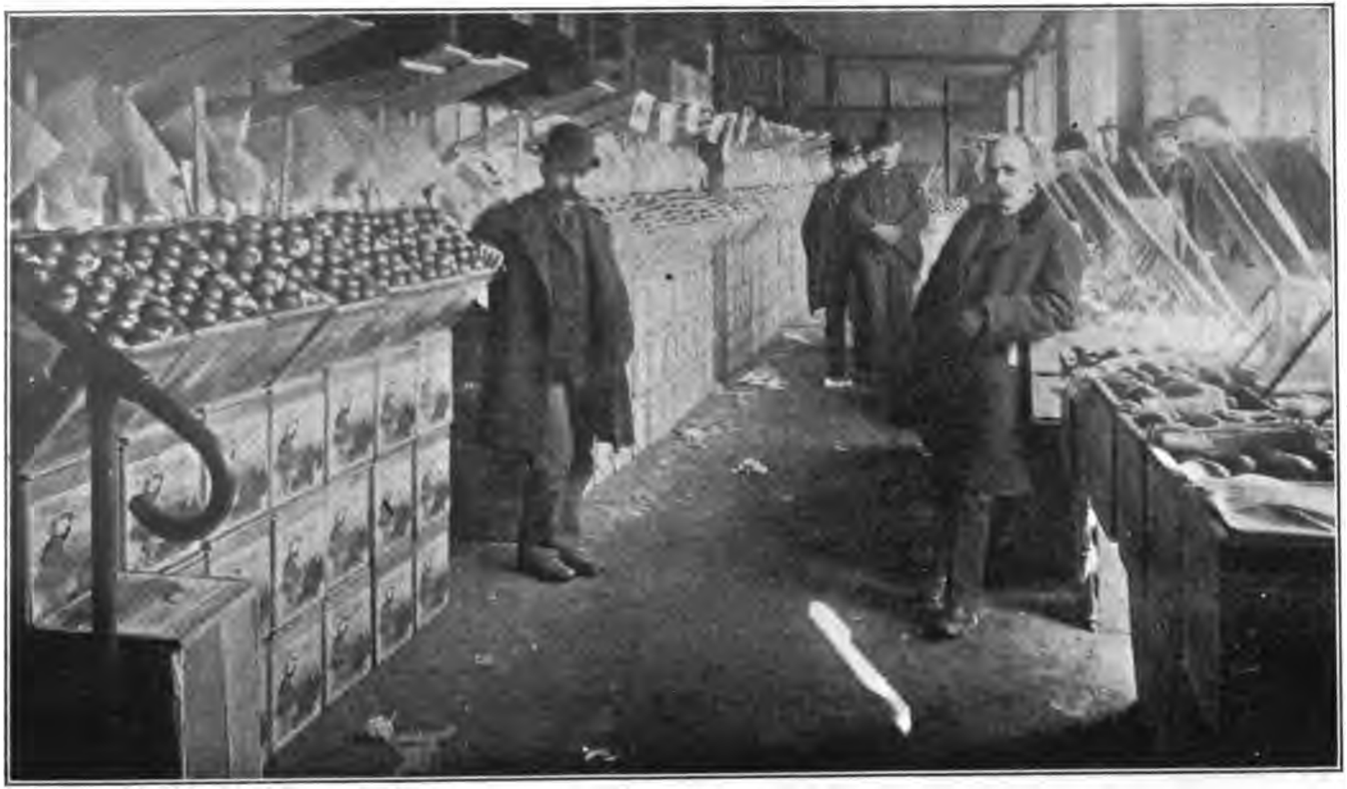


Fig. 2—Scene at the New York Fruit Exchange.

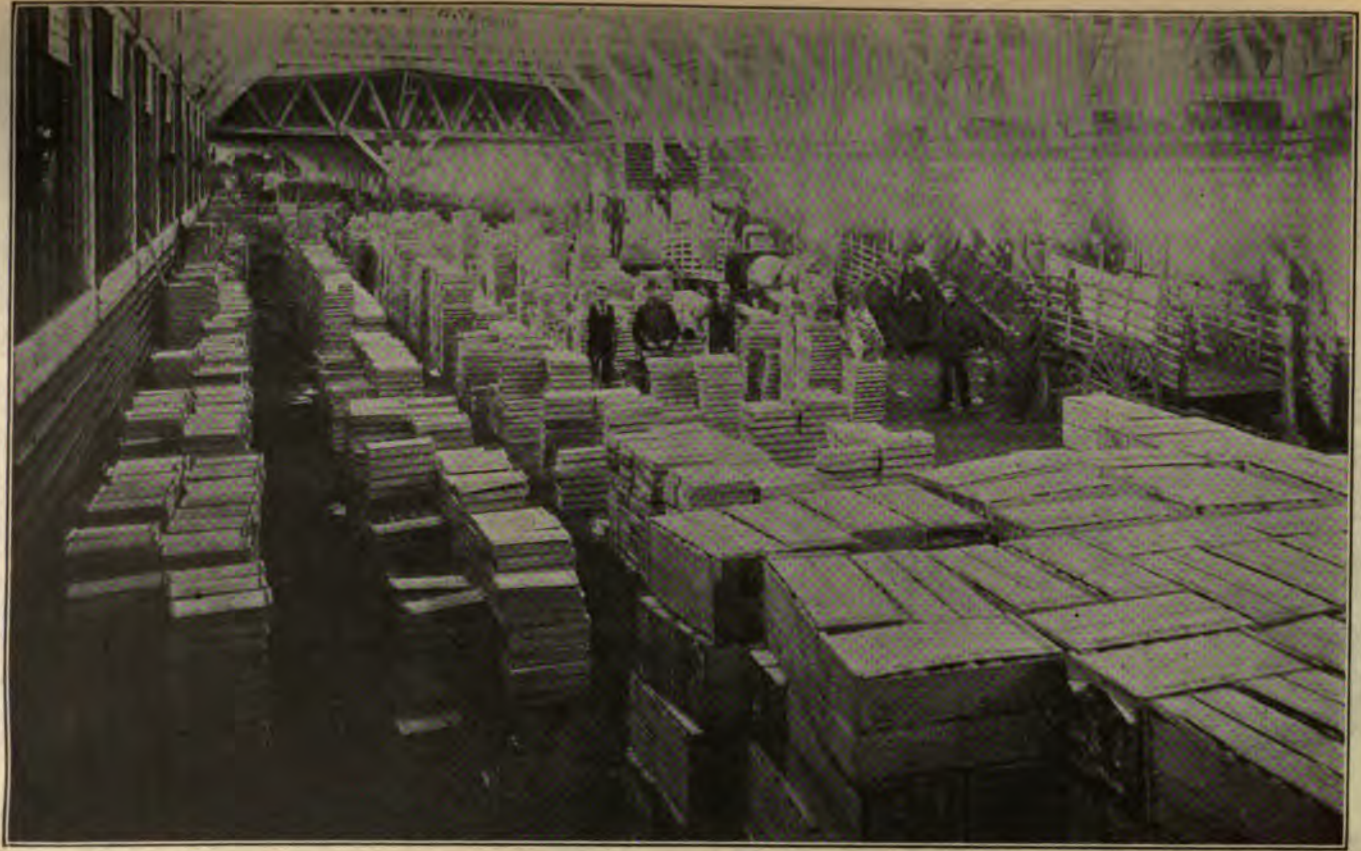


Fig. 3—The Wharf of the New York Fruit Exchange.

narrow aisles left so that the buyers may go up and down and inspect the fruit to be sold. Often the whole wharf is covered. Figures 2 and 3 show views of the Exchange's wharf. After the fruit is in position, dock inspectors make a report for publication of the condition of all fruit before selling begins. This obviates complaint after the fruit is sold and gives the consignor recourse in case of the old trick where good fruit is bought for a song by reporting that it had spoiled in transit. It also protects the buyer if fruit turns out other than what the opened boxes showed. Everything is sold on inspection. From the way-bills, the notes of the Exchange's agents unloading the cars and the numbers placed on each different lot of fruit on the wharf, a selling catalogue is made. One of these is given to each buyer as he enters the wharf. On these the buyer may make his notes on what he wants to buy and what he cares to bid on. At 9 A. M. a bell is rung and the sale, by auction, of the entire day's consignments begins in the large auditorium above the wharf. A firm of fruit auctioneers has its office in the building. The buyers are almost entirely Italians.

To hear the foreign language used as the selling proceeds, one could almost imagine himself in sunny Italy. The buyers are allowed to call for consignments they particularly desire. The bidding on choice lots is often as noisy as on the Stock Exchange. Clerks are on hand who record in the printed catalogues the prices as each consignment is sold. Reporters publish the catalogue and sales in the fruit trade journals. A shipper in California, who uses the exchange, can thus know the exact price for which each lot in his consignment was sold. This puts the selling on a perfectly open basis and the shipper does not need to depend on the word of any commission man. This, together with the condition report mentioned above, makes the Exchange a safe concern for both buyer and seller.

COOPERATIVE FRUIT SHIPPING.

Perhaps the greatest aid to successful fruit production today is cooperation. Many small lots of good fruit are sacrificed in the wholesale market of our large cities because they are lost sight of in the great bulk of stuff arriving. Large consignments receive consideration that is scarcely worth while to give to a few odd boxes or packages. It would be a great advantage in shipping if the growers at one point could cooperate and send their fruit not as small individual consignments, but as car lots. Commission merchants are glad to come to the growers and buy at the railroad if they can buy from a company, society or exchange, but they have not the time to hunt up growers to buy small lots. An association of growers can employ an agent to keep in telegraphic touch with market prices while few individual growers can. An association can secure uniform grades of fruit and can do a large business under a known brand. Baskets and fertilizers can be obtained by shipping associations at wholesale prices. Cars, rates and concessions can be obtained from the railroads by an association that no single individual could hope to receive. There are many successful shipping associations throughout the country. Below is given a few types of these associations or exchanges. The following from "The Fruit Grower," of St. Joseph, Mo., September, 1906, gives a type of association found successful in the west.

WATHENA FRUIT-GROWERS' ASSOCIATION.

"Early in 1905 a few of the growers met and decided that the thing to do was to organize a shipping association, and handle their own fruit and buy their own supplies. As a result the Wathena Fruit-Growers' Association was organized, and the first year the new organization had but twelve members. The firms which had previously handled the fruit of the growers claimed that the new association could not last; that farmers could not market their fruit to advantage, and all sorts of hindrances were put in the way of the association, in the form of extremely low prices for fruit packages, and unwarranted high prices for fruit at critical times—this being done to discourage the members of the association, and to entice them away from their organization.

The first year the organization did fairly well, but the members gained much in experience. This year, the second season of its existence, the association has made a splendid record. The organization has 100 members.

The association has bought all the material needed by its members, effecting a considerable saving. For instance, growers near St. Joseph paid 6 and 7 cents apiece for one-third bushel baskets in which to ship peaches; members of the association at Wathena paid 5 cents for the same packages.

At the beginning of the season every member signs a contract to market his fruit through the association; if the St. Joseph market offers a better price, he is to receive the consent of the manager before he can take his fruit across the river. This consent, however, is not withheld unless the association needs the fruit to finish filling a car which has been sold.

The association sells practically all its fruit on track, although it sometimes happens that small quantities left after filling cars are consigned to reliable firms. After the manager knows the price to be received for a car of fruit, he makes the "platform price" to the grower accordingly. This platform price is usually about 25 cents a crate less than the price the association receives. Suppose a carload of strawberries has been sold at $1.50 a crate; the platform price will be $1.25 a crate, and every grower who delivers fruit which passes inspection receives a ticket entitling him to $1.25 a crate, which can be collected by him when he chooses. The next day a car may be loaded at $1.75 a crate; then the platform price is $1.50, and the growers receive credit for the fruit delivered at that price per crate.

When the strawberry season is over the expenses of the association in handling the crop are deducted from the 25 cents profit retained on each crate, and the remaining sum is apportioned to the growers who furnish strawberries, according to the original sums they received as the platform price.

This same plan has been followed through all the season. This plan differs from that of the Paonia (Col.) Association, for that association waits until the end of the season, and apportions the returns, after deducting 10 per cent. for expenses. But that association markets the bulk of its crop in carlots and at about the same time and prices, for Elberta peaches and apples comprise the principal shipments. If this plan were to be followed by the Wathena Association, the man who secured early berries which sold for top prices would be on the same level with the man who had medium-season fruit, when prices were at the lowest point. Where fruits are being marketed over a long period, the Wathena Association managers believe their plan is the best that can be found, for then every grower's fruit sells at the price which is ruling when his fruit is ready. The platform price varies with the price at which the fruit is to be sold, but this platform price is the same for all berries delivered that day, so that while one car of berries may bring a higher price than another car of the same grade, all growers who delivered fruit that day are on the same basis.

"But suppose a car of fruit arrives in bad shape, on a long-distance shipment?" We asked Mr. M. Boeh, president of the association. "Who stands that loss?"

"That loss is borne from the fund of 25 cents which is retained as profit on each crate. This platform price, you will note, is the minimum price, and the 25 cents retained carries the expense and bears the losses sustained through the season."

To show how this plan works, the association marketed 7,000 cases of strawberries the past season, the crop having been cut short by dry weather. The bulk of this fruit sold at a platform price of $1.50 a crate, and $1.25 a crate was the minimum. After the strawberry season was over, and all expenses had been paid, the growers received an additional apportionment of an average of 12½ cents a crate, this being the sum remaining from the 25 cents a crate retained by the association. This is a remarkably fine record, showing that the expenses of the association were much less than 10 per cent. on the strawberry deal.

More than 9,000 cases of raspberries were handled, and the minimum price was $1.75 a crate. Over 15,000 crates of blackberries were sold; the market opened at $2 a crate, and the bulk of the crop was sold between $1.50 and $1.25 a crate, the latter being the minimum. On the St. Joseph market, where growers sold to local shippers, blackberries were selling at 90 cents and $1 a crate, while the same fruit was being marketed through the Wathena Association for $1.25 net to the grower. When one considers that about 2,000 crates a day were being sold by the members of the association, at an extra price of about 25 cents a crate, one can realize what the association has been worth to the growers in handling the blackberry crop alone. They saved $500 a day.

Of cherries the association handled 810 cases, and 703 cases of plums. At present peaches and grapes are being shipped in great quantities. In the ten days preceding August 29 the association shipped under refrigeration 17 carloads of grapes, averaging 2,700 baskets to the car, and 6 carloads of peaches. In two days 4 cars of grapes and 2 of peaches were sent out, at profitable prices, which shows up pretty well for an association only a little more than a year old. The association will handle at least 20,000 barrels of apples of high quality.

The members of the association are much encouraged, and have seen the necessity of maintaining their organization. Greater quantities of fruit have been shipped from Wathena than ever before in a single season, and at a time when all the neighboring country has good fruit crops. Notwithstanding the large crops, however, the prices received by the growers have been better than for many years, and instead of feeling discouraged, the members are planting increased acreages to fruits. Their organization has made the business profitable, when without it they were considering giving up the business.

The association guarantees its fruit. All fruit is inspected when delivered, and after that time the organization stands behind the guarantee. In order to maintain a good reputation for its fruit, the members are urged to plant varieties which will carry to market in good order.

The growers in almost any community can organize along the lines of the Wathena Association. Get a few of the leading growers to start the association; the first year discouragements will be met, but if the organization is properly managed, the next year things will come easier.

"One thing which cannot be too carefully guarded in an organization of this kind," said the manager, "is the reputation of the fruit sent out. Every grower must realize that he is a part of a mutual organization, and he must see to it that he does nothing which will injure the reputation of the association or his fruit. Each member is on his honor to pack nothing but good fruit, and it is to the credit of the members that they have established a high reputation for their fruit and their methods.

THE NORTH FORK FRUIT-GROWERS' ASSOCIATION.

The organization which attends to the marketing of the fruit grown about Paonia is known by the above title. This association has a membership of about 75, and looks after the marketing of the fruit of perhaps 25 or 30 more farmers.

This association, like many others of that part of the country, not only looks after the marketing of the fruits grown by the members, but it also handles the commodities they are compelled to buy—spraying materials, spray pumps, fruit packages, potato bags, fruit-picking baskets, corn and other things which the members need. These commodities are furnished to members at cost.

The association has a large building in Paonia, adjoining a railway siding which is used as an office, packing-house and warehouse. In addition to this central building there are a number of branch stations, used as packing-houses, for the benefit of growers living near them. Most of these branch houses have a sidetrack alongside, and each one is in charge of an experienced man, and the same rigid rules as to grading and packing fruit are in force there as at the central packing-house. During the busy season all of these branch houses and the central station are worked to their full capacity.

All fruit is packed at the packing-house. Each member of the association has a number, and all his fruit is brought to the packing-house in boxes bearing this number. We will suppose that we are packing Elberta peaches. The packers are all expert and are under the supervision of foremen and assistants, who watch carefully to see that no inferior fruit is packed. When a packer places a box of fruit on the packing table, the number of the grower on the box is noted, and every package of fruit put up from that lot bears the number of the grower. At the end of the day, when the fruit is loaded into cars we take an invoice, and every number is given credit for every package of fruit of the different grades which is put up from his fruit. At the end of the shipping season of the Elberta peaches, we sum up the sales, ascertaining the average price for the fruit of each grade, and each member is paid for the fruit he has furnished, less the commission of the association and cost of packing."

The sales of peaches are pro rated over a season. In this way there is no discrimination, and every member gets credit for just the quantity and quality of fruit he furnishes. If his fruit grades all fancy, he gets the benefit of the quality; while if his peaches are of low grade, then it has to stand on its merits.

When a member brings in fruit which is too soft to ship, and the association declines to pack it, it is placed in the boxes of the man who grew it, and belongs to him. He can dispose of it as he sees fit; he can sell to the evaporator or to the canner, or do what he pleases with it.

When the fruit is sold, it is sold by the association, and the individual members have no part in the transaction. It is necessary, therefore, that our organization be in position to guarantee the quality of all the fruit we sell. This cannot be done unless we pack the fruit ourselves. It is strange how blind one becomes when packing one's own fruit—why, it is almost impossible to see a wormhole or an imperfection of any kind. We have found it best to have the fruit packed by experts who have no interest in the matter except to see that only the right kind of fruit is put into the different grades.

At the end of the season our records show just how many boxes of each variety and grade were furnished by every member of the association, and the returns are pro rated among them. From the returns we deduct 10 per cent. commission for handling the fruit, and also 24 cents per box for the package and packing. One will readily understand the importance of trying to grow only high-class fruit, when it is realized that this charge for package and packing is as great in the case of the apples which sold for 69 cents a box as it was where the fruit sold for $1.61 a box.

PENINSULA PRODUCE EXCHANGE.

One of the best organized and managed of the cooperative selling associations that it has been my pleasure to look into is the Peninsula Produce Exchange of the Eastern Shore of Maryland. This exchange operates along the lines of the New York, Philadelphia and Norfolk and the Baltimore, Chesapeake and Atlantic Railroads. It has twenty-five local shipping points at each of which is an agent who inspects and brands the grade of produce and reports to the head office at Olney, the amounts and grades of fruit and truck received. The general manager in the head office is in touch by wire with prices in all the large markets and as soon as the daily reports of receipts and grades are wired in from his local agents is in a position to make his sales and place his consignments where the demand is greatest. The exchange spends over $10,000 annually in telegrams regarding crops, markets and prices. The capital stock of the exchange was reported in 1905 at $31,000. This was owned by the 2500 farmers who sell through the exchange. In 1905, a dividend of 7% was declared and in 1906 a 10% dividend. In addition to this a surplus was laid by for emergencies. The exchange forwards annually thousands of cars of both sweet and Irish potatoes in addition to other truck and fruit. It is reported as doing an annual business in the neighborhood of $2,000,000.

Cooperative selling associations and exchanges if properly organized and managed may be of immense value to the growers of truck and fruit crops. It gives the small producer the privilege of shipping in car lots, which today is the only economic base for commercial fruit and truck growing. It insures the advantages of a uniform grade of products. Buyers and large commission firms are willing to deal with a company, where they cannot take the time and expense to hunt up the produce of the individual grower. Many associations save considerable money to their stockkholders by the purchase of baskets and fertilizers at wholesale rates.

Like any other stock company the success of the enterprise depends largely on the loyalty of its stockholders and directors. A stockholder should not withhold his produce from the association when he can get a few cents better price elsewhere. In a season's business he would almost invariably do better to deal entirely through the organized channels of the company than to sell any of his stuff elsewhere. Local jealousies should be overcome and not allowed to impede business. A good general manager in such a company is essential, and he should be paid what he is worth. A man who can manage a million dollar business successfully and make it pay a good dividend can command the salary of a bank president and he should get it. Farmer's exchanges sometimes break up because farmer directors try to retain a $5,000 or $10,000 manager on $1,000 or $1,500 salary. These foregoing remarks give a few of the dangers to cooperative selling companies.

THE PROPER STAGE OF RIPENESS FOR PICKING FRUIT.

The fruit consumer and the fruit-grower are usually too far apart. Too often what is sweet, juicy, luscious fruit in the orchard and vineyard of the grower is on the table of the consumer an over-ripe, pulpy or partially decayed product. It is a lamentable fact that many of our finest fruits are very bad travellers and present on arrival in town, a very unattractive appearance. Many growers do not know the proper time to pick fruit; that is, the stage of maturity that puts it on the market in good condition. Very often one sees fine, large pears and peaches that are rotting when the packages are opened because the fruit has been allowed to get too ripe on the tree before picking.

Sometimes when the early market is slack there is a demand for immature fruit for cooking purposes. The first early, summer apples may be profitably picked when they get big enough for cooking. This will be while the seeds are still white and before the fruit shows much signs of coloring. The market is always looking forward to the earliest apples. Dessert and winter apples should not be picked until well colored. Those that stay on the trees late are better flavored than those picked early. Winter apples will usually keep better if allowed to ripen in the cool weather of the fall, though by this waiting there is danger of heavy windfalls. Apples should not be separated from the twig by a straight pull but by a twist upwards or sideways. The ease with which some fruits separate from the twig by a nip sideways gives a good idea of maturity. With summer apples two or three pickings are generally made. Pears should always be picked from the tree before becoming mellow and be allowed to ripen after storing. The time at which the first full-sized fruits begin to fall is the indication of proper picking time. Peaches are picked for market when they show the clear or bright colors. They should not be pinched to test maturity. The experienced picker has a way of rolling the flat of his hand over the ridge of a peach and the feel means the same to him as grain in the sack does to the miller's thumb. Plums can be picked greener than any other fruit. With plums, size is about all one needs look for, as the fruit seems to ripen as well off the tree as on it. Grapes on the other hand should never be picked from the vine till fully ripe and sweet, for they will not develop sugar and ripen after they are picked. I have known unprincipled growers to spoil the market for white grapes by shipping Niagaras before they had become ripe and sweet. Tasting is the sure test with grapes. Cherries are picked with the stems on, as soon as they are big enough, and they always have the color with the size.

A day, or even a few hours too long on the tree may mean the loss of the whole cherry crop by brown rot. Color is the shipper's test with strawberries. Raspberries may be picked as soon as they will separate from the receptacle.

PICKING AND PACKING APPLES.

All handling of the apple crop should be done with the idea of bruising the fruit as little as possible. In all apples of good quality a bruised specimen soon becomes a rotten one. Apples should be picked into bags or padded baskets and carefully rolled from these into the barrels or onto the sorting table. A very handy picking bag is made by placing a pebble in a corner of a grain sack and tying the corner by means of the pebble to one side of the mouth of the bag. This makes the bag into a loop, which may be hung over the neck of the picker. The mouth of the bag comes to the front and is held open by passing a stiff bent wire under the hem. This kind of picking bag leaves both hands of the worker free for picking. Figure 4, showing the picking of experimental apples at the Experiment Station orchard, shows one of these bags in use.

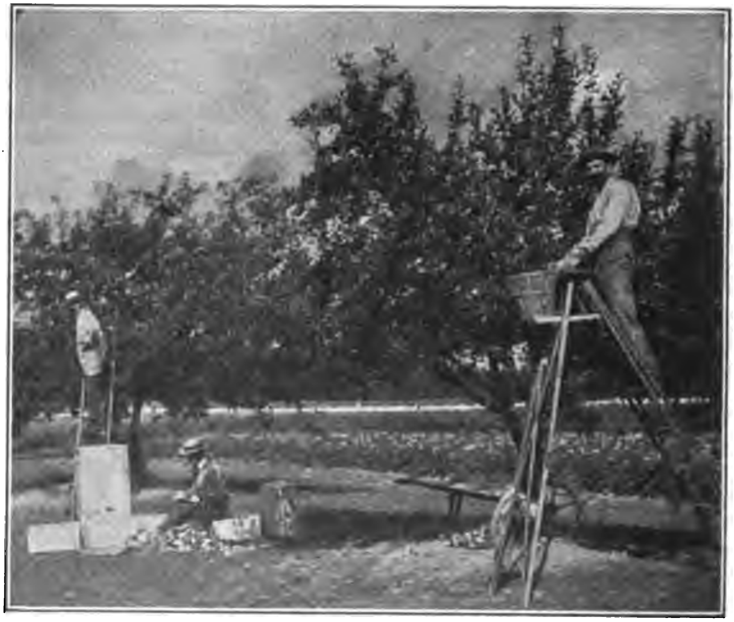


Fig. 4—Packing Apples at the Maryland Experiment Station.

In commercial orcharding it is generally most economical to have picking and packing work going on concurrently. This saves putting the apples on the ground and having to handle them again. A gang of pickers will empty their picking bags and baskets directly onto a portable sorting table placed between the rows on which they are working. This table is placed on low truck wheels and has a single whiffletree so that a horse can move it to any desired point as work proceeds. A cut of this kind of sorting table is shown in Figure 5. It should be made large enough to hold not less than two barrels of fruit. The rear bolster is higher than that at the open end so that culls can be rolled out. A long, heavy plank is placed on the ground on each side of this table on which the barrels are set for filling. The sorters pick the apples from the table into padded wicker baskets, which have low or folding handles, which permit of their being placed down into the barrel before being dumped. Apples would be greatly injured if dumped from the mouth to the bottom of the barrel. The fruit is sorted into two grades, firsts and seconds. In sorting exclude all fruits that are ripe, for if a fruit is ripe at packing time it will soon decay and spoil its neighbors. Fruits that are too green or poorly colored should be left out as they are always of inferior texture and flavor. Undersized, diseased, wormy, bruised or misshapen specimens should of course go as culls. The culls are allowed to roll into a pile from the lower end of the grading table.

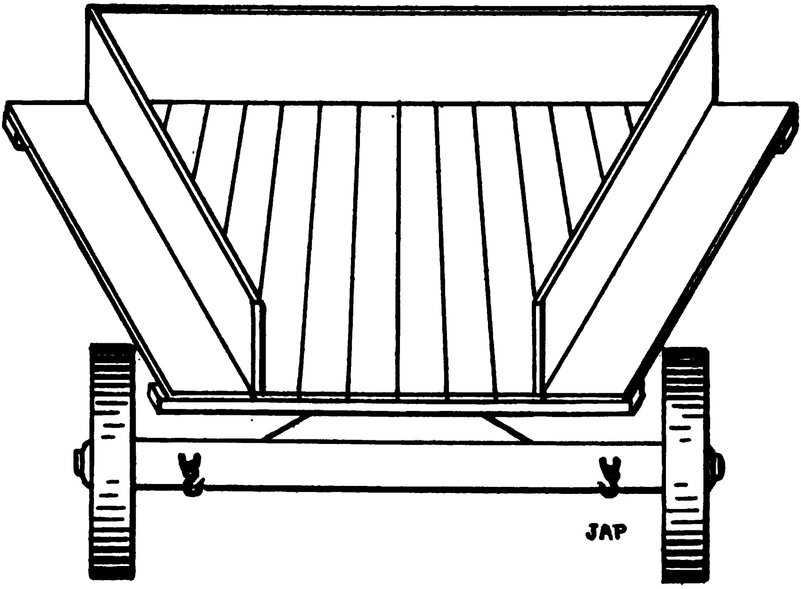


Fig. 5—A Portable Sorting Table.

The first apples placed in the bottom of the barrel should be "faced," that is placed with the stem end down. If the facing is well done, the barrel will on being opened appear as in Figure 6. If the stems are long they should be removed from this face layer so as not to cut into the skin as they are pressed against the head of the barrel. There is a small pair of nippers made that will do this work very quickly without injuring the apples. A nice effect may be made by "quartering" the second layer, that is turning the bright check so that it will show through between the apples of the face layer when the barrel is opened. It takes but little extra time of an expert packer to do this and the better general appearance of the barrel on being opened is well worth the little extra trouble. The barrel should be filled up with just the same kind of fruit as is used for the facing. It never pays to put anything but good fruit into a package. As the filling proceeds the barrel should be "racked" that is rocked vigorously back and forth on the plank. This settles the fruit into the crevices and insures a tight barrel when it is headed. "Racking" cannot be well done on the ground without the plank and the plank also keeps the heads clean and fresh from branding and labeling. Several barrels may be put on a long plank and the number of barrels necessary used for the second grade. The first grade, or No. 1, includes all apples that are of proper size for the variety, of good color, free from insects, rot, blemishes and bruises. The second grade, or No. 2, includes apples which are too small to go in the first grade, but are sound and reasonably free from insects and blemishes.

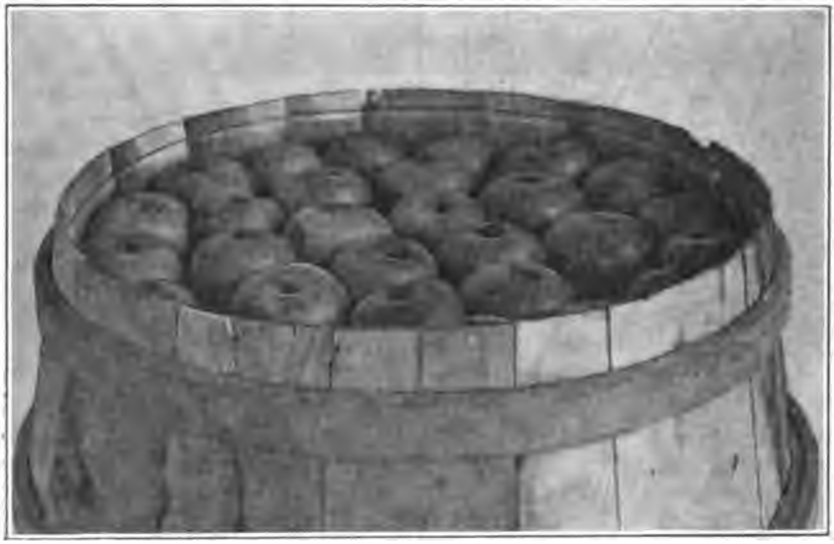


Fig. 6—The Top of a Well-Packed Barrel of Apples as it Opens up in the Market.

The following rules define the grades of apples as set down by the National Apple Shippers Association.

"Requirements for No. 1 Apples—The standard for size for No. 1 apples shall not be less than 2-½ inches in diameter, and shall include such varieties as the Ben Davis, Willow Twig, Baldwin, Greening, and other varieties kindred in size. The standard for such varieties as Romanite, Russett, Winesap, Jonathan, Missouri Pippin, and other varieties kindred in size, shall not be less than 2-¼ inches. No. 1 apples shall be at time of

packing practically free from the action of worms, defacement of surface, or breaking of skin; shall be handpicked from the tree, a bright and normal color, and shapely form.

Requirements for No. 2 Apples— No. 2 apples shall be hand-picked from the tree; shall not be smaller than 2¼ inches in diameter. The skin must not be broken or the apple bruised. This grade must be faced and packed with as much care as No. 1 fruit."

Figure 8 shows a clean, even grade of apples as taken from a well-packed barrel of apples. Figure 9 shows selections made from a barrel of apples fraudulently packed.

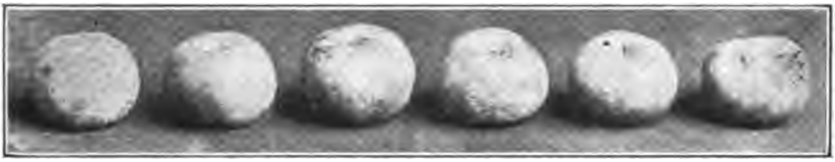


Fig. 8—Specimens from an Honestly-Packed Barrel of Apples.

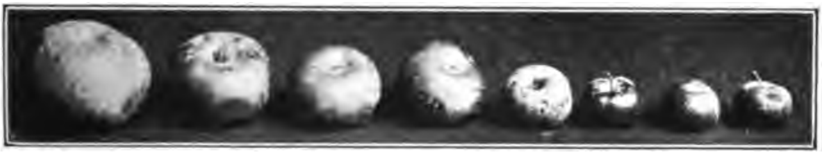


Fig. 9—Specimens from a Fraudulently-Packed Barrel of Apples.

When ready for heading the fruit should stand as evenly as possible at about ½ to ¾ inches above the chime of the barrel. A corrugated paper cap or excelsior cushion should be placed on, the head laid and the press applied. Figure 7 shows a barrel with the screw press in position ready for driving down the head. Just beneath the head may be seen the excelsior cushion. After a little experience a handy man learns lots of little knacks about heading up fruit. One of these is driving down the hoops before the press brings the head entirely down to its goove in the staves. This brings the head in place with a satisfactory snap that retains it before a nail is driven. The press is now taken off and the hoops driven down tight and nailed in a slanting manner so that the ends of the nails catch and hold the head. For export shipping it is safer to nail a couple of pieces of hoops inside of the chime as head lining. The middle hoops are now driven down and each nailed with three nails. When headed up in this way the fruit in the barrel will be tight so that it will not rattle on being hauled or moved about. Any barrel in which the fruit is heard to rattle has not been racked and pressed sufficiently in packing. The fruit becomes bruised and rotten in transportation and the barrel is known as a "slack." Every shipper knows how these slacks reduce the profit of the shipment.

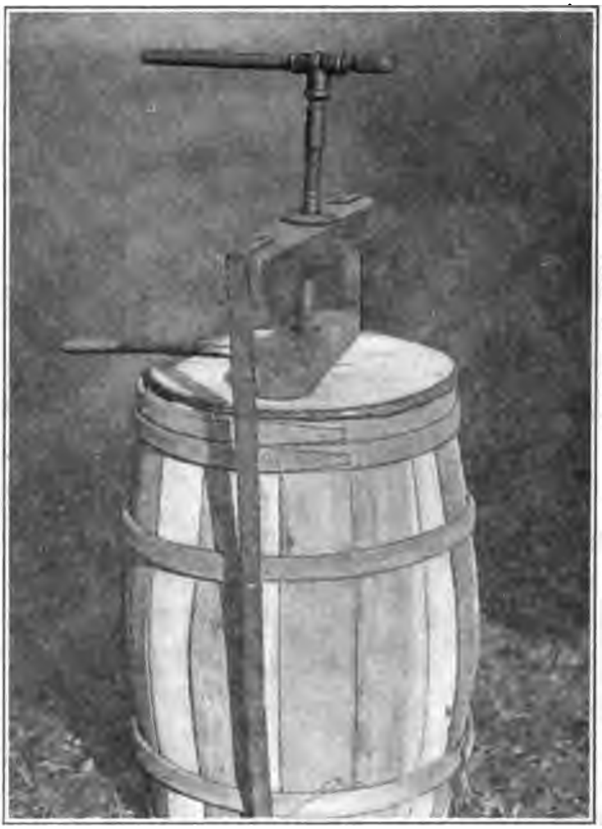
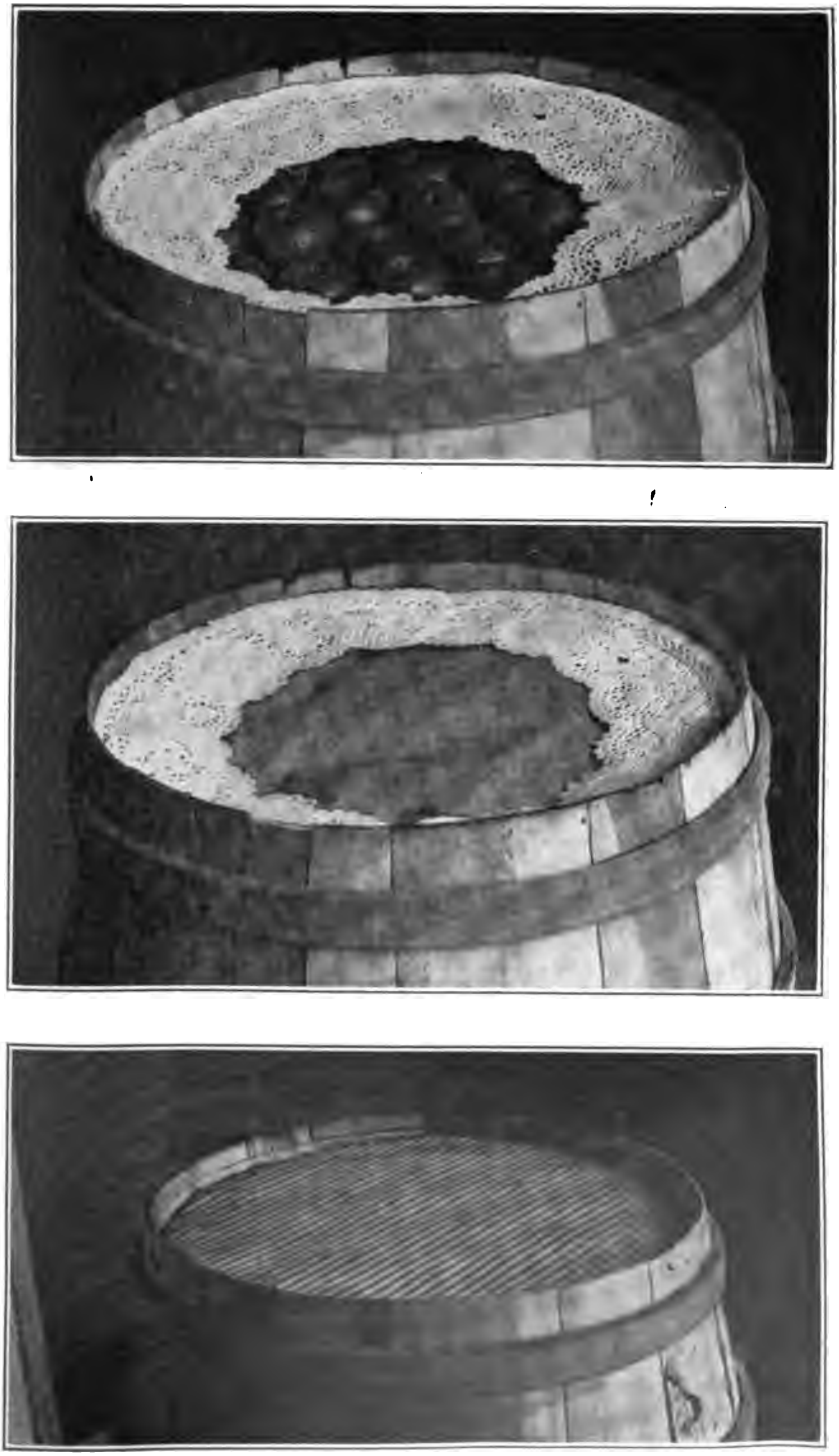


Fig. 7—Putting the Head in Place. (Note the Press and the Cushion Just Under the Barrel Head at the Right.)

Some growers use fancy paper covers, which gives the fruit a dainty appearance on being opened. Figures 10 and 11 show the fancy covers in use. In Figure 11 a paper cap is shown just beneath the cover. Figure 12 shows a corrugated paper cap, which is very useful in protecting the fruit from bruising while being pressed. This corrugated cap or the excelsior cushion should always be used in packing apples for export.

In Canada wonderful advancement has been made in apple shipping and the securing of the best export trade by the passing of a penalty law for careless or fraudulent packing. This law requires that all fruit packages shall be branded with the name and address of the grower, and give the name of the variety and the grade of the fruit. The law fixes a standard grade. The law provides for a regular system of inspection and provides for fine for neglect to conform to the requirements.



Figs. 10 to 12—Fancy Paper Used in Trimming Barrels of Fancy Apples—Winesaps in this Case. In the Lower Figure is shown the Corrugated Cap, the Best Thing for Putting in the Heads at Time of Packing.

BOX PACKING OF APPLES.

The bulk of apples handled in the market still comes in barrels, but the first-class apples that bring the fancy prices are handled in boxes. The trade in fancy apples is increasing annually. The barrel is too rough a package for a first-class fruit and is much too large. Many people who would not think of purchasing so large a package as a barrel of apples would gladly buy a box of them. One good box of apples is but the first of a long line that will follow. Last year our apples at the Experiment Station were very conveniently marketed in 40-pound boxes and sold for $1.25 a piece. Hood River Apples is a brand that is found in the market wherever high-quality apples are called for. This brand is not yet a decade old, but its demand in the market has been phenomenal. This year I saw two-layer cases containing 40 apples selling for $1.50, nearly 4 cents per fruit. This almost rivals the price of oranges.

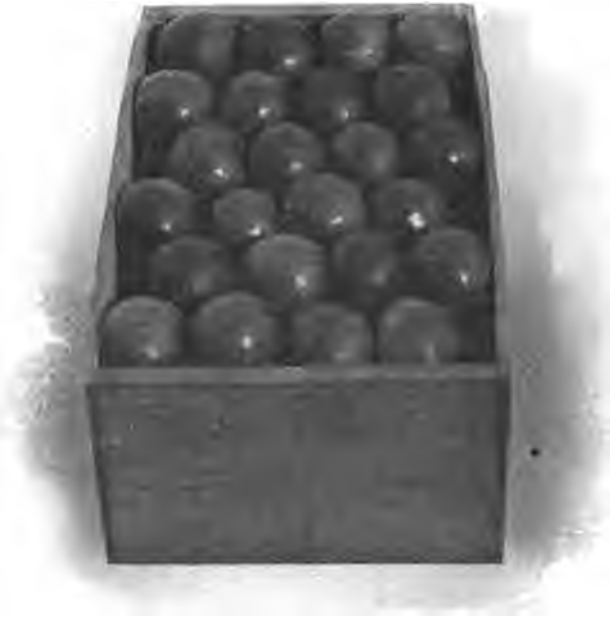


Fig. 13—A Good Pack of Apples.

A Western Maryland grower is putting apples up in boxes and finds that the cost of 3 boxes and one barrel are about the same, and by wrapping the apples in paper he finds that one barrel will fill four boxes. These apples sold for the same price per box as could be gotten for a barrel, thus giving a fine profit for the small extra expense.

The specifications for these boxes were obtained from the Division of Pomology of the United States Department of Agriculture and are as follows: White pine heads 11¾-in.x9-inx⅝-in. dressed on

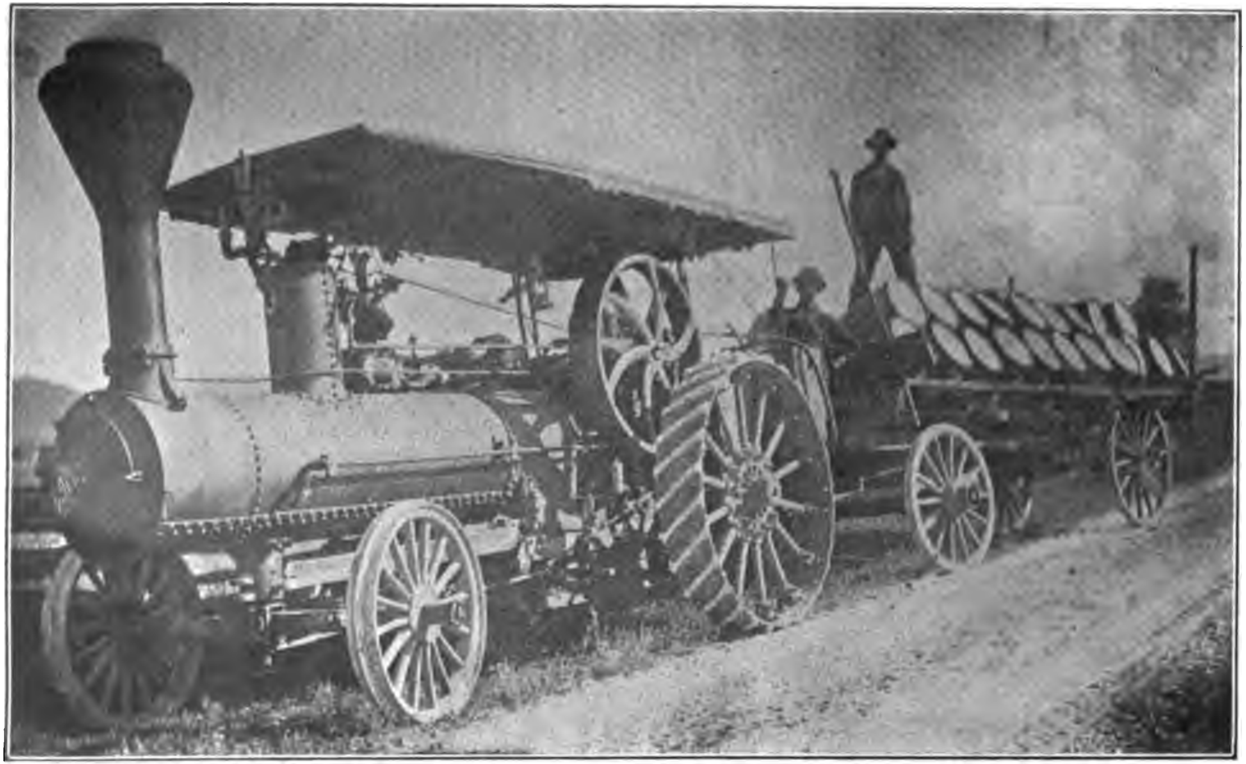


Fig. 15—Hauling Apples to Market in Western Maryland.

both sides. Sides one piece 19¾-in.x9-in.x¼-in. smooth sawed and dressed on one side. Top and bottom each in two pieces 19¾-in.x 5¾in.x¼-in. smooth sawed and dressed on one side. The cleats for putting on top, 11¾-in.x¾-in.x⅜in. For express shipments where the boxes would not be cleated in as they are in car lots, I would advise using ¾-in. instead of ⅝-in. for heads and ⅜-in. instead of ¼-in. stuff for sides, bottoms and tops.

Figure 13 shows a box of select apples properly graded and packed. Each fruit is perfect and is packed in layers so that every fruit fits into its place. Being a much smaller package than a barrel the box does not need much pressing especially since every fruit is fitted in place by hand. When the box is filled the apples of the top layer should stand slightly above the edge of the box. One end of the cover is nailed and the other pressed down and sprung in slightly for nailing. This gives a slight bilge to the box, which holds the fruit firm. Cleats are nailed on each end of the top to make the cover secure and to facilitate the passage of air when the box is stored in car or on shipboard. For long distance shipping the boxes should be cleated in firmly to avoid shifting and bruising of the fruit.

Figure 15 shows a load of 50 barrels of Western Maryland apples being hauled to shipping depot by traction engine.

SHIPPING PEARS.

Pears, especially winter varieties, used to be quite largely shipped in barrels like apples. One sometimes sees them in market today in barrels. Pears of fine quality like Bartlett are shipped in boxes or in ⅝-bu. Delaware baskets. Unfortunately of late years, owing to the ravages of blight, pear growing has greatly decreased and many of the finest varieties have disappeared from the market. Kieffers are able to take care of themselves in almost every package, but bring best returns when neatly put up in box form.

PACKING AND SHIPPING PEACHES.

Peaches were formerly shipped in what was generally known as the Delaware basket. Now the best peaches go to market in the six-basket carriers. See Figure 16. This is a neat slat carrier, somewhat like a berry crate containing six veneer baskets, holding about a half-peck each. Figure 17 shows one of the six baskets packed with peaches. This package carries the tenderest peaches to market in good condition and as they look well on arrival they usually sell for the top price. This package is to be recommended for shipping all first-class fruit. It is too expensive a package to be used for any but the first grade of fruit. Probably no better fruit package for fine fruit has ever been introduced than the six-basket carrier. It can be used for plums or grapes or any high-class fruit and always carries it in good condition and shows it off to best advantage in market. Figure 18 shows one of the trays of the carrier used effectively for marketing

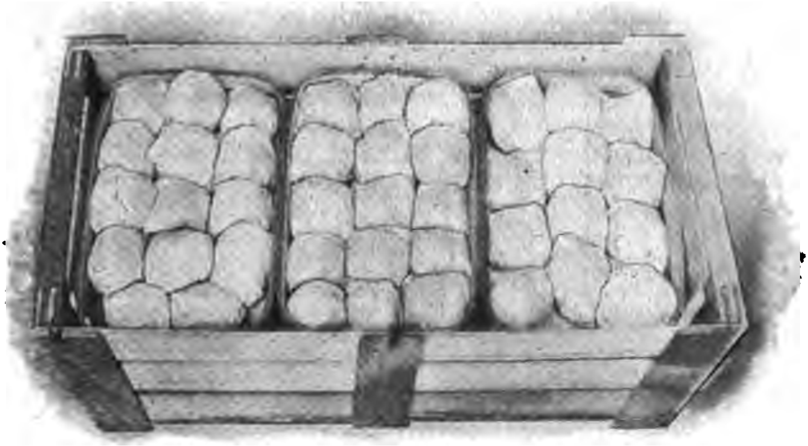


Fig. 16—A Six-Basket Carrier of Peaches.

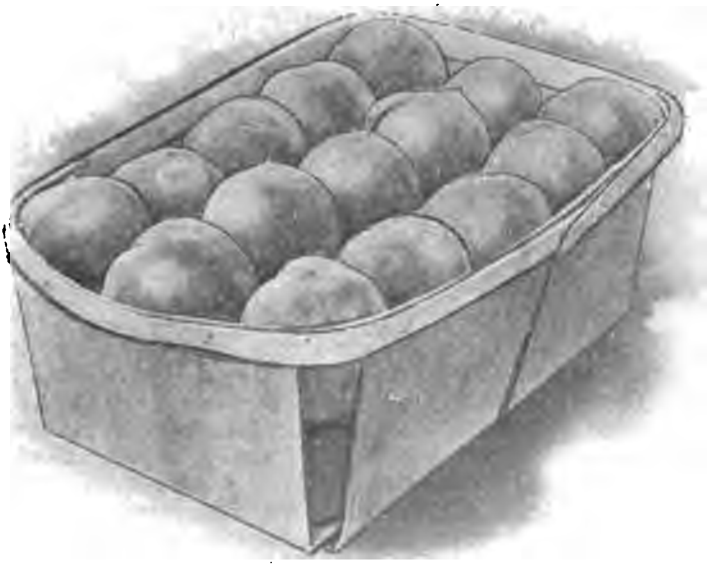


Fig. 17—A Basket Packed With Peaches.

Seckel pears. It is no uncommon sight in our large markets to see fine peaches in these cases selling as high as $3.50 per case. Any one will admit that that is a pretty good price for three-quarters of a bushel of peaches. The dignity of this fine package should be maintained and it should never be degraded by carrying anything but No. 1 fruit.

All general-crop stuff is best handled in the round peach basket. The large bushel basket is not a suitable package for fine fruit like peaches. It does not permit of good packing and the large bulk crushes the tender fruit and renders it unsightly.

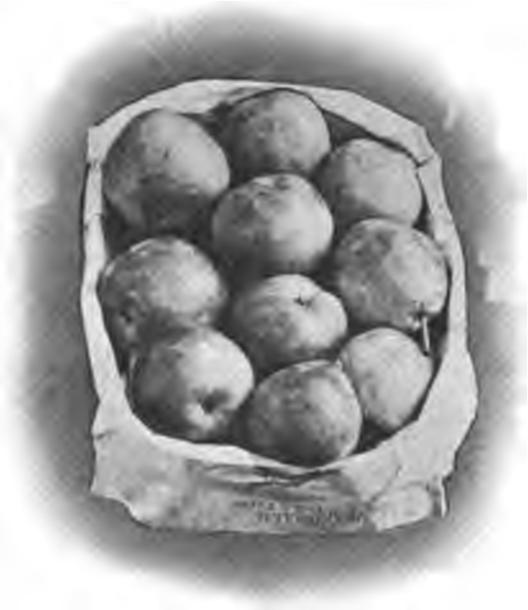


Fig. 18—Seckell Pears, with Veneer Basket.

The grader pictured in Figure 1 is a great labor-saver in grading peaches. It separates the fruit perfectly as regards size into three grades. The sorting table, pictured in Figure 19, is of great assistance in packing peaches. It is separated into shallow compartments that will hold about two bushels of fruit. The side at which the packer stands has a narrow shelf on which the veneer trays are placed while being filled. In the bottom of the compartment is a canvas, which is tacked to the upper edge opposite the sorter. This keeps the fruit from bruising and facilitates the worker's movements in drawing the fruit towards the trays. In the veneer trays or baskets each fruit is fitted into place. Unless the grade is extra large it holds two layers. The table, as will be seen, is constructed in sections which alternate so that fruit may be dumped on the table from either side and the trays carried off handily when filled.

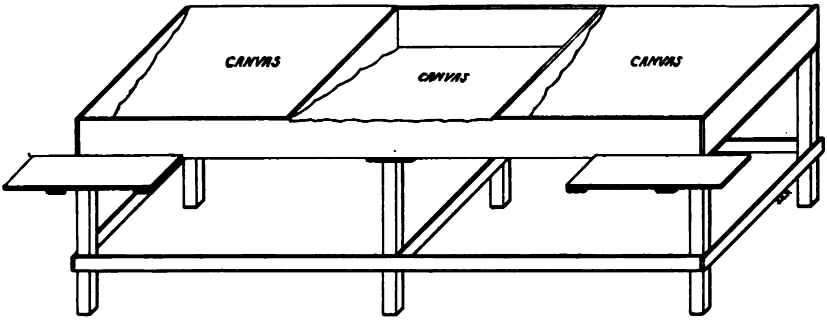


Fig. 19—A Sorting Table for Packing Peaches.

Figure 20 shows a handy picking basket for peaches. As will be seen it is made from an ordinary Delaware basket. The strap goes over the shoulder of the picker and leaves both hands free for gathering the fruit. When filled the basket is easily dumped by unhooking the snap.

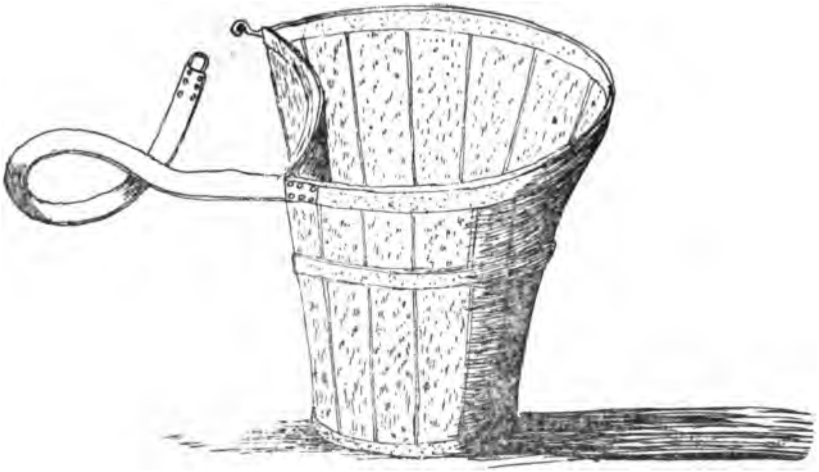


Fig. 20—A Handy Picking Basket for Peaches.

MARKETING PLUMS.

This being a special peach State, plums are not grown in very great quantities. Native American plums are often found on sale locally, but are seldom seen in large city markets. With the advent of the Japanese plums and their hybrids, which seem to be much at home here, plum growing has been on the increase. As small baskets are required by present markets, one often sees Japanese plums for sale in crates like strawberries. Some growers in this state have marketed plums very successfully in this way, a package of which is shown in Figure 21.

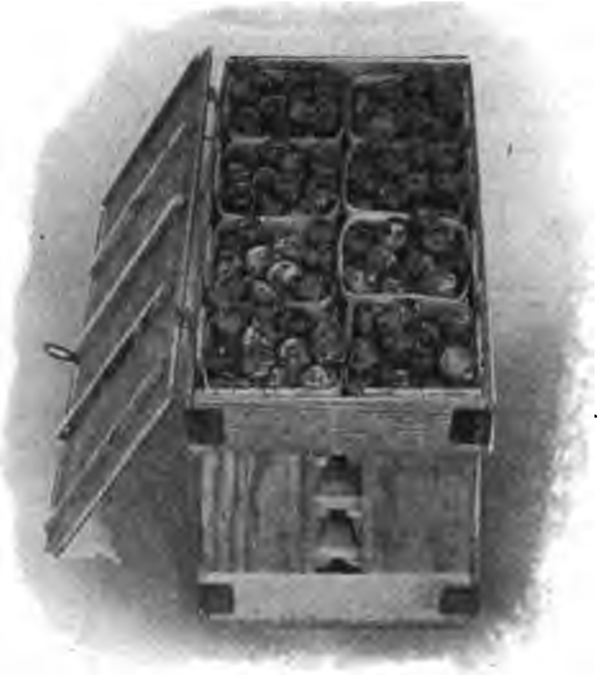


Fig. 21—A Crate of Plums.

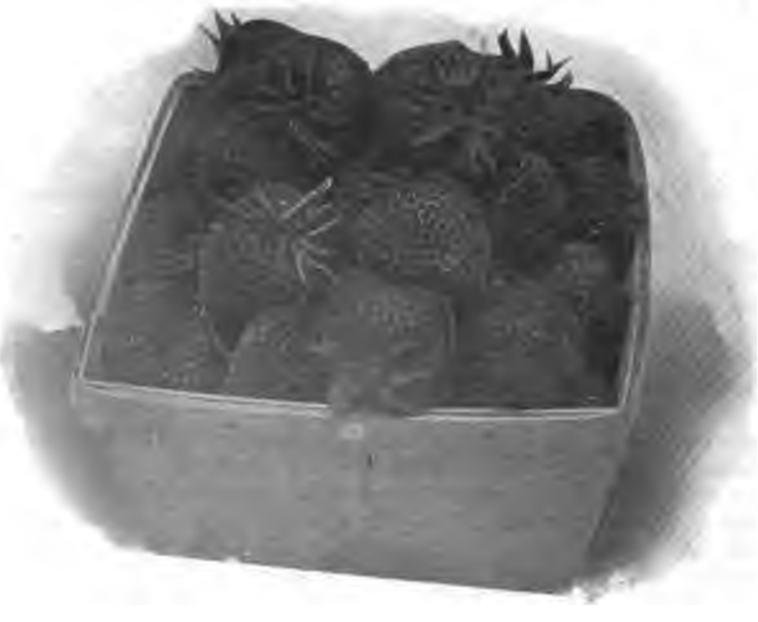


Fig. 22—The Kind of Strawberries That Sell.

MARKETING BERRIES.

Berries are of course picked in the veneer quart basket, but there has been considerable variation in time past as to the size of crates used. Before the advent of the gift package it was the practice of express companies to return crates free. Large crates were then used that would hold 48 to 60 quarts. Now the market wants only 24 and 32 quart basket carriers and whenever a large crate is used it seldom brings first-class returns to the shipper. Besides not carrying the berries well, the large crate holds too great a quantity of perishable fruit for a retail grocer to handle at one time, while in the season he might handle many of the 24-quart carriers. It need hardly be said that all fruit packages sent to market should be clean and neat, yet one often sees, in our large markets, good fruit begging for a purchaser because it is packed in baskets covered with dust, hayseeds and cobwebs. These may appear to be trifling things, but with goods sold almost entirely on their appearance they mean all the difference between success and failure. If baskets or packages are carried over from one year to the next they should be stored away that they may come out in a fresh, clean condition. It does not pay to grade strawberries except in picking them. It is fruit like that in Figure 22 that brings the best prices. It is important that the grower use varieties that will produce maximum crops of large, firm, well-colored berries. Pickers should be instructed not to pick small defective or over-ripe fruits. These always give less trouble when left on the vines.

One of the greatest drawbacks to successful marketing of strawberries is the failure of some growers to mulch their plants. In southern regions mulching may not be considered necessary to protect the plant from cold, but it is always advisable to mulch to keep the fruit clean. Sandy, gritty berries are an abomination to the eater and usually a drug on the hands of the seller. I was told by some wholesale commission men that they would never allow their buyers to go into strawberry regions where growers did not make a practice of mulching their beds.

PACKING AND MARKETING GRAPES.

Grapes are not as often seen in the local markets of this state as they should be. Very small quantities are grown and shipped, and what are used locally come almost entirely from the north. Grape growing in Maryland has decreased largely on account of the rotting of the fruit just before picking time. This trouble, however, is preventable, and our soil and climate are capable of producing large crops of fine grapes. Owing to careful spraying at this Experiment Station we had not over 5% of rot this year (1906) in our whole vineyard of many varieties. It is well known, too, that the growing season of 1906 was very hot and wet; just the conditions most favorable for the development of rots and all kinds of fungous diseases. In spite of these most unfavorable conditions we were able to mature a fine crop of grapes. Some early varieties are not much subject to rot and are especially adapted for growing in this State as they would supply the market before the northern grapes were ripe.

Experience has shown that grapes are most profitably marketed in small, rather than in large baskets. The 3-lb. basket pictured in Figure 23, was bought on the open market for 30 cts., 10 cts. per lb. A price of this kind ought certainly to encourage more extensive vineyard work.

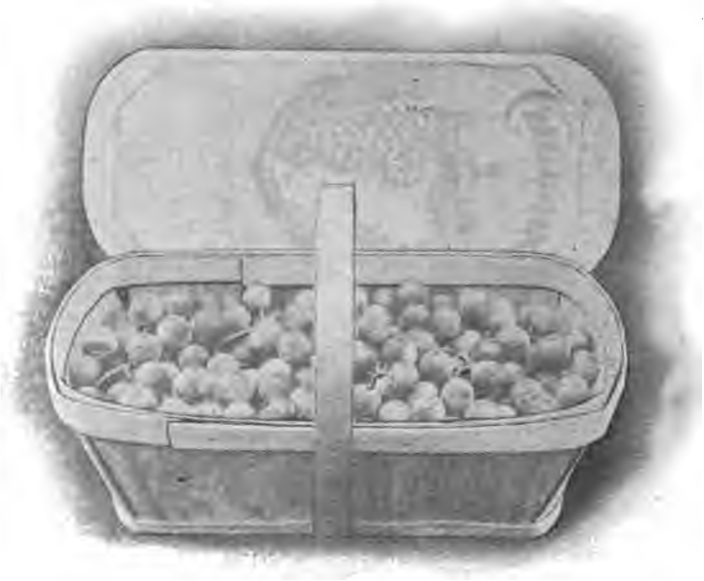


Fig. 23—A 3-lb. Basket of Grapes, Bought on the Open Market.

MARKETING TRUCK CROPS.

Truck growing is a modern horticultural outgrowth due to improved facilities for rapid transportation. Before the advent of extensive steam navigation and the present great extension of railroads each city and town depended for its supply of vegetables on its immediate surrounding country. Today the most distant states in the the Union are sending truck by boat and train load to the great northern centres of population.

WHITE OR IRISH POTATOES.

Bulk or winter potatoes usually go to market in barrels, topped off with a burlap cover as in Figure 24. There is always a regular trade in this staple article of consumption. Grading is as necessary with potatoes as with apples. The little potatoes though they fill up the chinks and corners detract very much from the appearance of the product and should always be left at home. Figure 25 shows an even grade taken from a well-packed barrel. Figure 26 shows the irregular tubers we too often find. Good potatoes should be smooth, free from knobs or second growths and should have shallow eyes. Varieties should not be mixed in the same barrel or package. It hurts their sale to have long potatoes mixed with round ones.

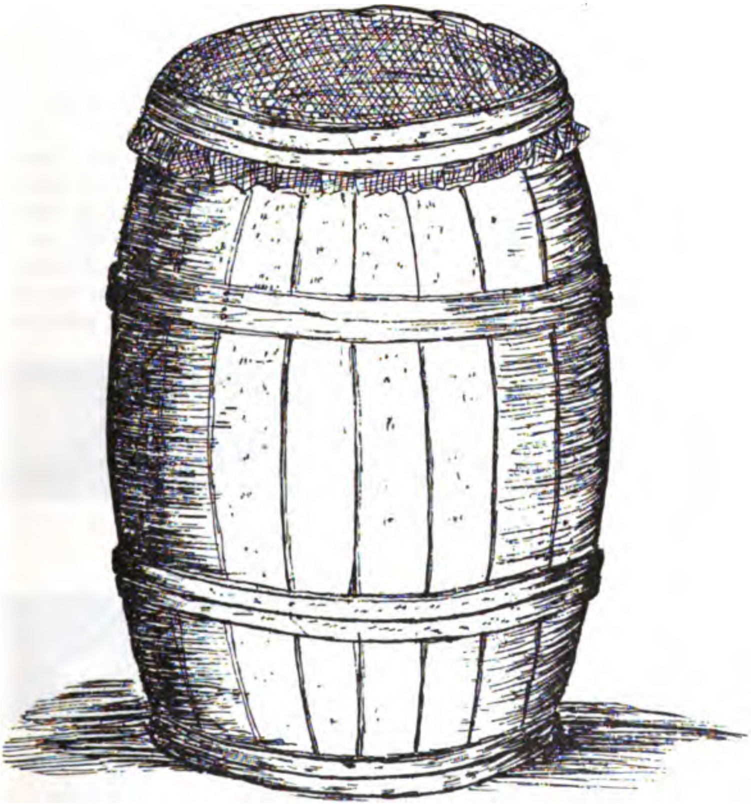


Fig. 24—A Barrel of Winter Potatoes.

The earliest new potatoes in the market are always sure of a ready sale at tip-top prices. There is nothing that gives the trucker more pride, and profit, too, than to beat his neighbor into the market with early potatoes. At that time potatoes are potatoes and do not retail by the barrel, but by the peck and half-peck. Such potatoes have to be handled carefully and are usually shipped in the 1-3 barrel veneer basket. See Figure 27. Care should be taken not to break the tender skin more than possible so as to avoid the ragged appearance seen in some new potatoes when exposed in the market.

Figure 28 shows a good basket of early potatoes.

PACKING AND MARKETING SWEET POTATOES.

Though coming out of the soil there are few vegetables or even fruits that are more perishable than are sweet potatoes. They require the most careful handling and treatment to arrive in market in good salable condition. In the first place, being a southern plant, the sweet potato is very susceptible to frost or cold weather. For this reason "sweets" should be dug before the vines become frozen The first light frost that just tips the outer leaves is a good sign that the time for sweet potato harvesting has arrived. Many people claim that the freezing of the vines injures the quality of the potato and also causes them to rot. A very easy method of harvesting is to plow out the rows using a revolving coulter to cut the vines.

The potatoes may be sorted as they are picked up or hauled in bulk to cellars where they may be graded later when they are cured and the market is right. Whatever method of harvesting is used care should be taken to handle the potatoes as little as possible so as to avoid unnecessary bruising. They should never be thrown into wagons, but picked into baskets and these dumped by a careful sliding movement so as not to scar or bruise the potatoes. Use padded baskets to avoid abrasion. A potato that is cut, broken or bruised when it is dug almost invariably rots unless used for immediate consumption. Potatoes wanted for storage should be kiln-dried. This is usually done by placing them, in not too large quantities, in cellars provided with slatted bins. Pipes, flues or a small stove may be used to dry off the roots. For the first few days the temperature should be carefully kept at about 90 degrees Fahr., ventilating when necessary. During a period of two weeks the temperature is gradually lowered to 60 degrees Fahr. when the fires may be extinguished. This treatment is found to produce a sort of ripening process in the potatoes and after this they show very little injury from handling. In the South sweet potatoes are successfully stored by being piled in conical heaps and covered with corn stalks or pine straw. When cold weather

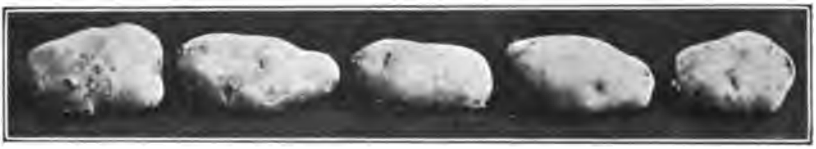


Fig. 25—Uniform Potatoes Desirable for Shipment.

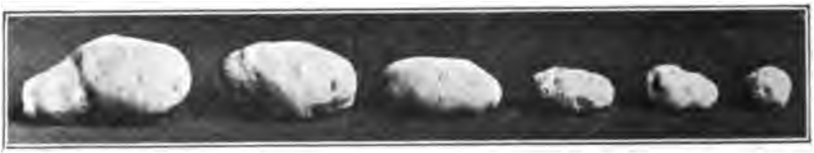


Fig. 26—A Mixed Lot of Potatoes Undesirable for Market.

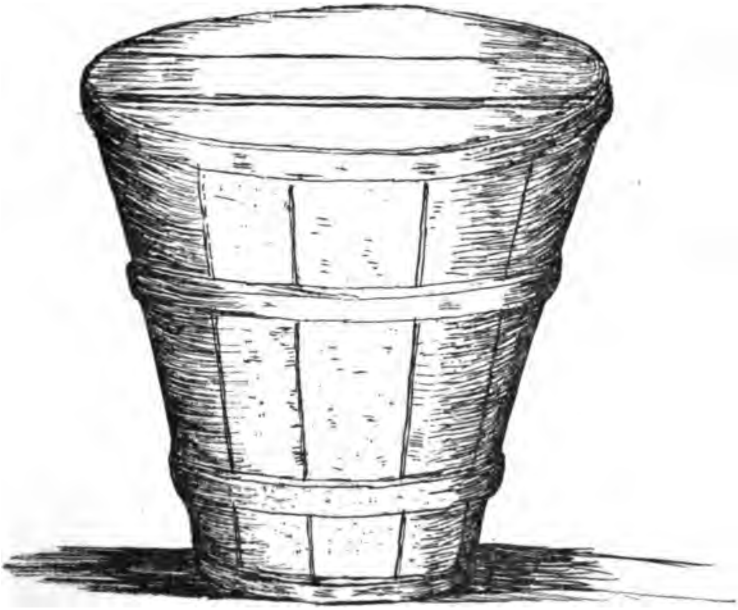


Fig. 27—The 1-3 Barrel Veneer Basket for Sweet Potatoes.

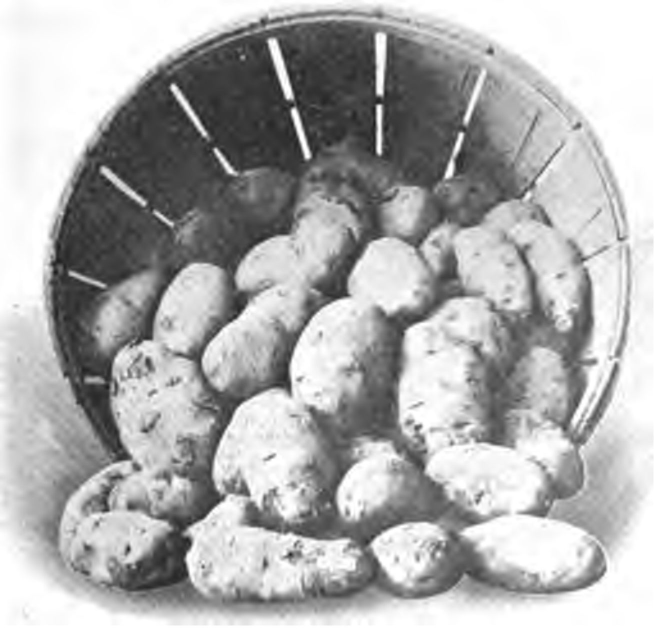


Fig. 28—A Good Basket of Early Potatoes.

approaches a cover of a few inches of earth is thrown upon the stalks or straw. If undisturbed, this covering will usually keep the potatoes till well on into spring.

GRADING SWEET POTATOES.

Sweet Potatoes for the best markets should always be graded. All over-sized roots, the thin ones, the rough, misshapen ones and the "elbows" should be used for stock food or sent to starch factories. What the market wants is a smooth root of a clear orange color and of about 2 to 2½ inches in diameter and roundish rather than long. Figure 29 shows a good sample of marketable sweet potatoes. The usual shipping package for sweet potatoes is the burlap-covered barrel that is used for Irish potatoes. See Figure 24. The 1-3 barrel veneer basket, see Figure 27, is a neater and better package for first-class, well-graded "sweets" and usually brings fancy prices. The most careful shippers of sweet potatoes are now using paper liners for the baskets. The liners keep the potatoes clean and free from dust and protect from any sudden drop in temperature during shipment. These liners are made and sold quite cheaply by many paper manufacturing companies. The liner is made and cut so as to neatly

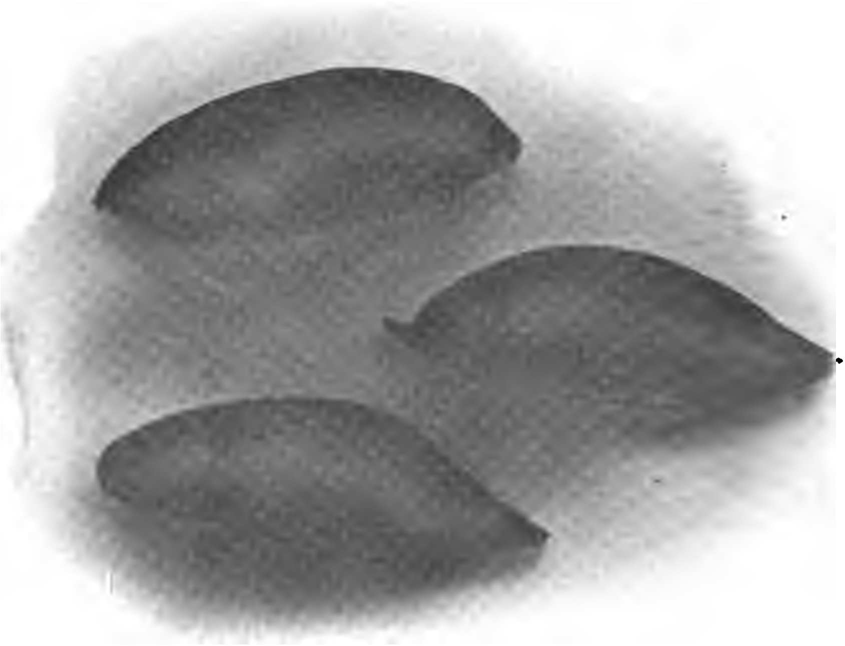


Fig. 29—A Desirable Type of Sweet Potatoes for Market.

fit the sides of the hamper and has a circular top that fits in snugly under the wooden cover. When opened this makes, with good stock, a very salable product.

LETTUCE.

Lettuce is one of the most profitable truck crops. There seems to be an almost unlimited demand in winter for good, fresh head lettuce. The loose sorts do not seem to be wanted in most markets. The best shipping carrier for lettuce is the veneer basket. As lettuce is light in weight compared with most truck the ½-barrel size of basket seems to be most in favor. Figure 30 shows a well-packed basket of head lettuce with cover removed.

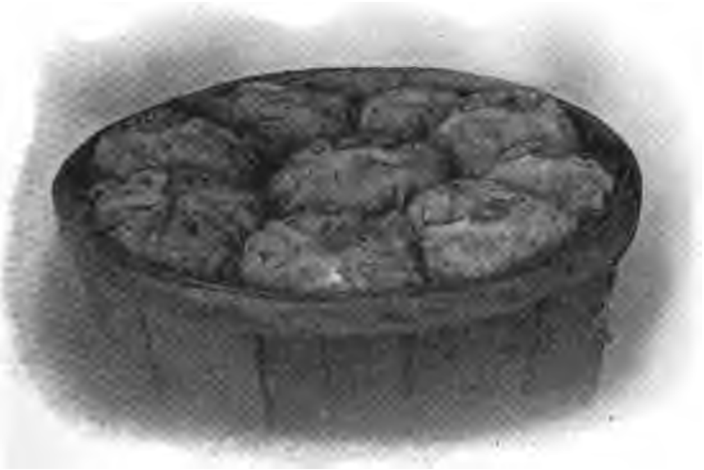


Fig. 30—A Basket of Head Lettuce, Properly Packed.

CUCUMBERS.

Cucumbers being heavier than lettuce are shipped in 1-3 barrel veneer baskets. Figure 31 shows a basket ready for heading up. The cucumbers, as will be seen, are not placed in the basket indiscriminately but are arranged by hand so as to fit closely and to leave a flat surface on top for the placing of the cover. Of course here, as elsewhere, grading is necessary and the more uniform the package the better the sale.

LIMAS, SNAP BEANS AND PEAS.

Limas, snap beans and peas are best handled in the veneer basket, 1-3 barrel size. Figure 32 shows such a basket of limas opened. As this sort of truck loses moisture rapidly in shipping, the basket

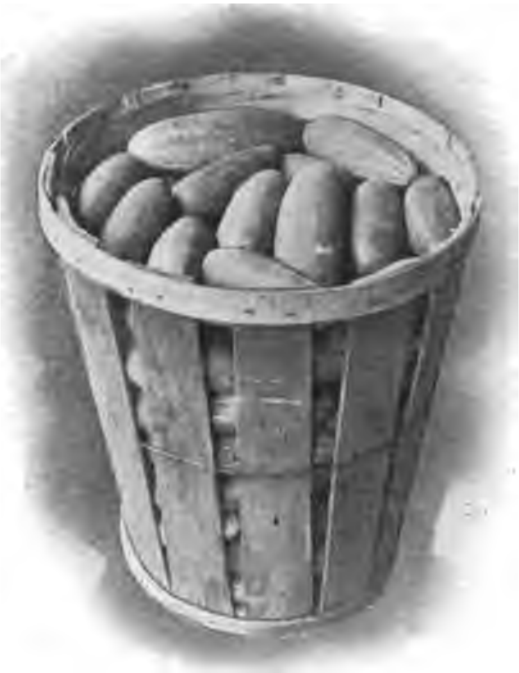


Fig. 31—A Basket of Cucumbers Ready for Heading Up.

should be well packed and filled before the covers are placed on. There is always more or less shrinkage and if a basket is not full on being opened it does not find ready sale. Truck of this kind should be placed on sale as soon as possible after leaving the field.

PACKING AND MARKETING CANTALOUPES.

Scarcely any branch of horticultural work has increased of late years like the growing of cantaloupes. All markets handle them and are glad to extend their season by getting early and late supplies from all sections of the country. Many varieties of melons and cantaloupes were formerly seen in our markets but present requirements have banished almost all but the Netted Gem or as it is popularly known today, the Rocky Ford. This cantaloupe besides possessing the finest texture and highest flavor is almost round and is thus easily packed. Recent seed selection in this strain has produced a very fine fruit, heavily netted, regular in form and weighing about 1 lb. each. They are put up in crates as in Figure 33, holding 3x3x5—45 fruits. In packing cantaloupes they should be graded as to size. The fruits are placed in the case so that the ribs of the fruit all run lengthwise of the package. This may seem a trifling thing, but it gives the package a special appearance and helps to hold its unique position on the market. None but the heavily netted fruits should be marketed. Figure 34 shows a cantaloupe packing-shed in the height of the shipping season. The fruit is gathered in the field in bushel baskets and hauled to the shed and dumped into the sorting tables. The table is divided into burlapped sections somewhat on the principle of the peach sorting table in Figure 19.

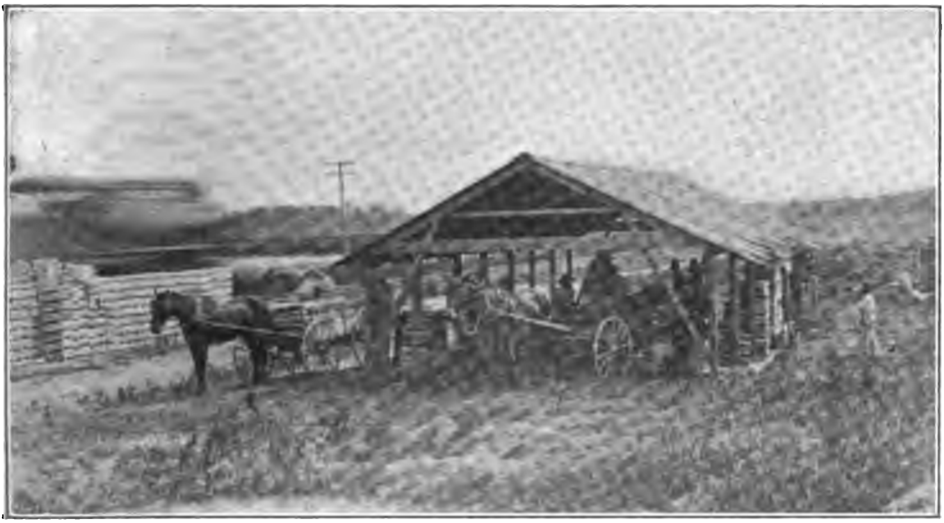


Fig. 34—A Cantaloupe Packing Shed.

Asparagus Bunched for Market.

MONTREAL MUSKMELON.

Another fancy fruit product is found in the famous Montreal muskmelon. These melons of the Hackensack type are found in some of our large northern markets and often sell for fabulous prices. They are packed with dried grass into large wicker baskets. Each fruit is perfect of its kind and each has on the blossom end a red gum label. On seeing these melons in the market for the first time I priced them and the salesman replied $1.25. I remarked that it seemed rather cheap for the whole case. The merchant stared at me as if I were crazy and said $1.25 per melon, the whole case is worth $10.00. Instances might be multiplied of a wonderful trade built up on fancy brands of fruit.

ASPARAGUS.

Asparagus where it can be grown free from rust is one of the best paying of truck crops. It occupies the season between frost and green peas. In isolated locations where the asparagus beetle is yet unknown the green asparagus can be raised. This is more tender and of better quality than the white asparagus, which is bleached by banking and cutting the stalks just as the points appear at the surface. The white or bleached asparagus is firmer and looks somewhat better than the tender green stalks. The stalks are usually cut in the field and bunched in an open packing shed. The bunches are made by hand and weigh about two pounds. Fairly long stalks are preferred, but if they are a little short, are made into thicker bunches. Bunches are usually tied twice with string or raffia. Some growers use elastic bands. There are patent bunchers made for holding the stalks for tying and cutting to the proper length. Small home-made stands can be constructed, which assist considerably in the bunching operation. Figure 35 shows two cases of asparagus packed for shipping. On top will be seen several uniform bunches.

CABBAGE.

A considerable portion of the cabbage crop is handled in bulk. When forwarded by car-load or ship-load the heads are cut from the stalks with a heavy knife or light hatchet and all the outer leaves left on. When prepared for market they are dressed up by removing the outer unbleached leaves. Cabbages are often shipped in ventilated or slat barrels. Tight barrels keep them too warm and may cause rotting. By far the best carrier for shipping cabbage is the barrel-size crate. This carries the heads securely, packs in well on board train or boat, and shows the quality of the stuff when arriving in market. The heads should be packed in the crates carefully by hand so that the carriers will not be slack when received by the wholesalers. Figure 36 shows a cabbage-packing scene. The crates in the foreground have been used in collecting the heads in the field. Those on end in the background show the cabbages ready for shipping.

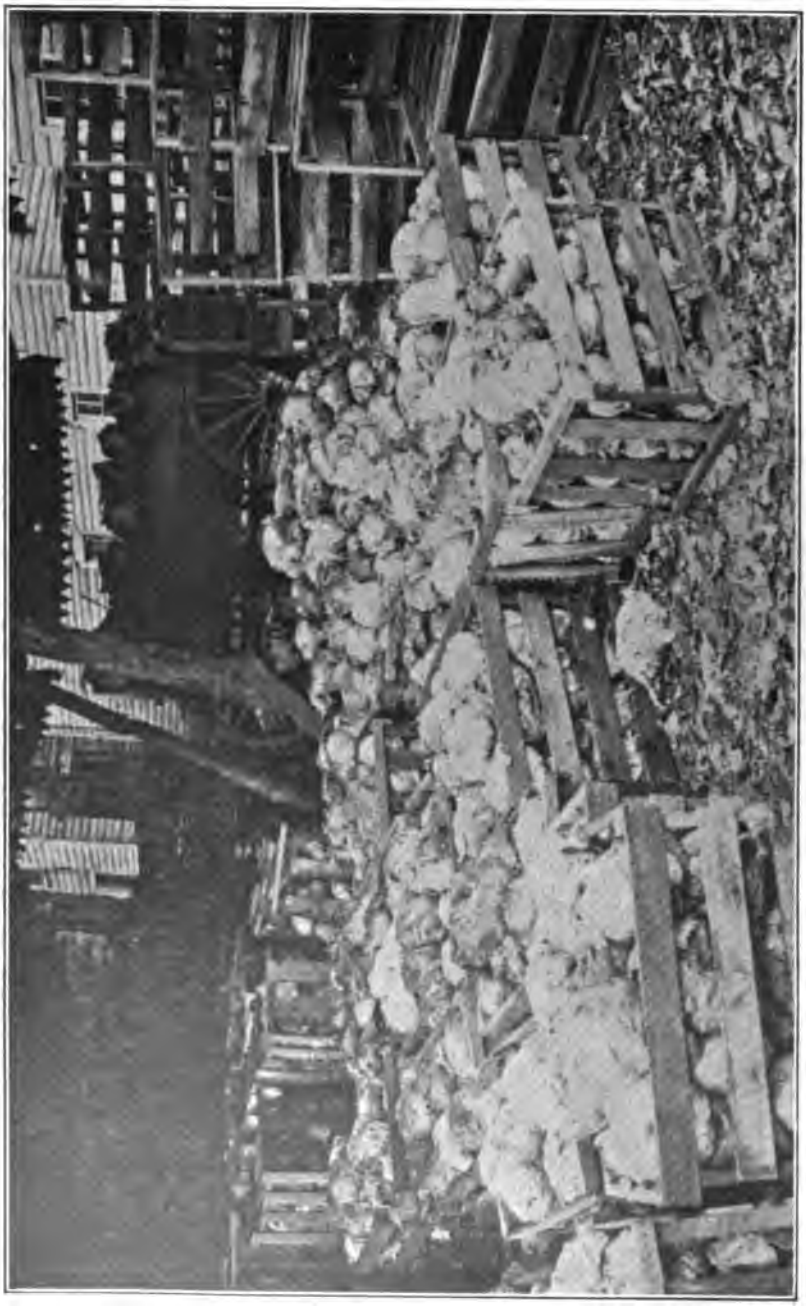


Fig. 36—Packing Cabbage for Market.

CELERY.

Celery, when fully grown and bleached, is prepared for market by trimming off the roots so as to leave the short solid stem. The tops are never cut, but any loose outside stems and leaves may be removed. The stalks when thus dressed are made into bundles of one dozen each, and tied twice with light tape to hold the stalks together in position. These bundles are packed into an open crate, which is 22x24 inches and 20 inches high. The crate is packed full, placing the stalks in upright position. The crate will hold ten or a dozen bunches of ordinary size. Larger or smaller crates of this kind can be used to accommodate varieties with larger or smaller stalks. The crate has no cover and the leaves project over the top if the stalks are of extra length. Sometimes celery is shipped in crates where the bunches are laid flat and the tops lapped, but it often causes the leaves to decay and gives the stalks an unsightly appearance. The open crate described above is, by far, the best carrier for celery.

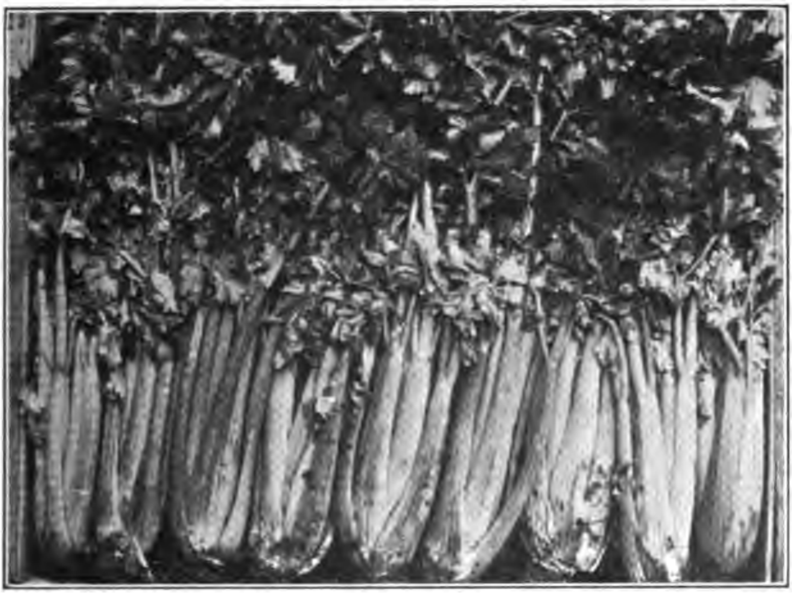


Fig. 37—Celery Packed for Market.

Figure 37 shows a crate of celery packed for shipment.

EGGPLANT.

The fruit of the eggplant is a fine vegetable that is rapidly becoming more appreciated and better known on our markets. The fruits, though large, are rather tender and should be carefully handled to preserve their smooth shining surface and deep purple color. They are best handled in the 1-3 barrel veneer basket; the same size used for cucumbers and early potatoes. Cauliflower can be packed and handled in the same size basket as the eggplant. Figure 38 shows a basket of eggplant as opened in market.

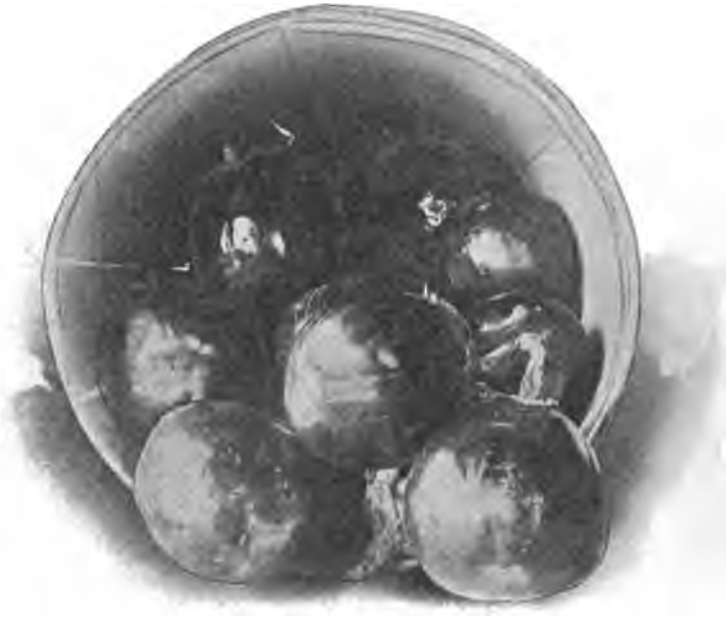


Fig. 38—A Basket of Eggplants as Opened in Market.

HUCKSTERING.

There are few cities of any size with agricultural surroundings where there is not a considerable huckster trade in home-grown fruit and vegetables. Other things being equal there is usually a preference for vegetables and fruits that still have upon them the dewy freshness of a country morning. The charm of early vegetables is their crispness. This is often lost in imported truck unless handled by express or refrigerator shipments. The home-grower who raises his vegetables and brings them fresh to the door is like the early bird in the proverb. But the freshest of vegetables soon shows the effect of a summer sun and crisp lettuce and fresh peas soon give evidence of an unattractive and unsalable appearance. Vegetables should therefore be exposed to drying as little as possible. A canvas cover for the whole load is a great protection on the way to market, but in the city it hides the attractive wares and impedes selling. Figure 39 shows a huckster's wagon designed to keep vegetables fresh and salable. The glass-panelled sides and ends advertise the contents and show the whole load off to great advantage.

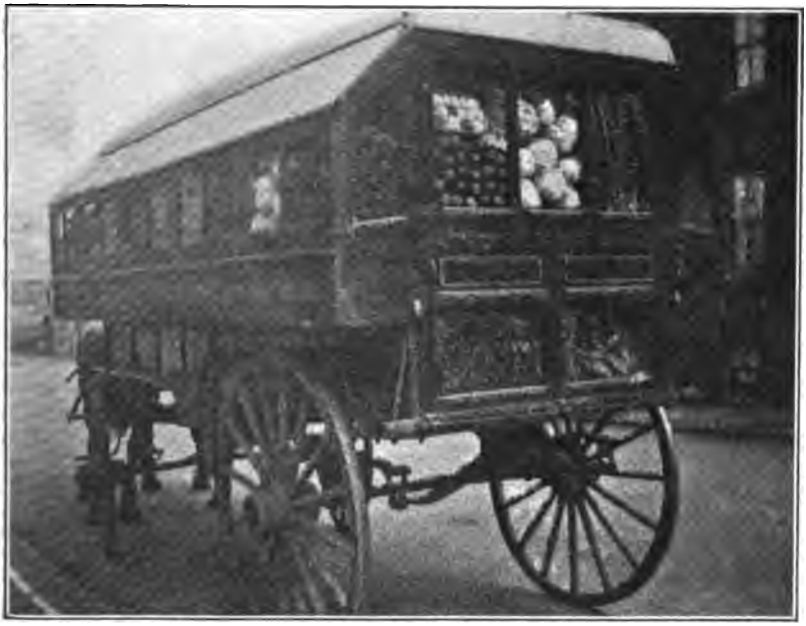


Fig. 39—A Good Huckster's Wagon.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 117. APRIL 1907.

THE DIGESTIBILITY OF MOLASSES FEEDS.

BY H. J. PATTERSON AND RAYMOND OUTWATER.

PREFACE.

The experiments reported upon in this bulletin were planned by and carried out under the direction of H. J. Patterson and the details of the feeding were supervised by and the sampling and chemical work performed by Mr. Outwater. At the time of Mr. Outwater's death on February 9, 1907, he was in the midst of preparing the tables for publication. The final calculation of the results and arrangement of the tables and the discussion and preparation of the bulletin was done by H. J. Patterson.

The increase in the production of sugar in the United States in recent years has caused the utilization of the Molasses by-product to become an important factor.

At one time most of the molasses produced in the United States was sold for table use; but now this trade takes but a small percentage of the product. The demand for molasses has also relatively decreased owing to the poorer quality of the product as a result of the improved methods for sugar extraction.

During the past few years large quantities of molasses has been used for fuel at the place of manufacture and a considerable amount has been thrown away as there was no demand for it for any purpose whatever. Large quantities of certain grades of molasses have also been used for the manufacture of alcohol and this use will now probably increase with the more liberal provisions allowed by the recent denaturized alcohol legislation.

Molasses Stock feeds have been used extensively in Germany and other European Countries for many years. During the past few years the question of the use of molasses as a stock food has been agitated considerably in this country and resulted in the placing of a number of molasses feeds upon the market and the consumption of large quantities in this way.

The scarcity and high price of all cattle foods has brought to the Experiment Station numerous inquiries as to the value of every new feed on the market and particularly of the many molasses feeds. In order to have more definite data than was available on this subject it was decided to make a special study of the food value and digestibility of molasses and molasses feeds. In this piece of work the effects of molasses on digestibility and the digestibility of the molasses feeds most commonly found in this market was determined. The work as originally planned included several more than reported upon but the tests with these could not be carried out as there was no feed available on the market at the time they were wanted for the experiment.

HISTORY OF THE USE OF MOLASSES FEEDS.

The first suggestion of the use of molasses as a stock food was made by Hermstadt in 1811. The first recorded ration was used in 1830 and consisted of chopped straw and 220 pounds of molasses per day for 2000 sheep, 80 head cattle and 20 horses. In 1850, rations mentioned by Stockhardt, Henneburg and Stohman, consisted of Molasses Oat-straw and Hay. They limited the amount of molasses to 8 pounds per 1000 pounds, live weight of the animal fed. By 1860 the use of molasses became quite general in Germany, France and Russia, and by 1870 its use had spread to England. Owing to the cost of molasses and the variability of the product, the demand for it did not increase rapidly until about 1890 when the increased production caused a marked decrease in price. It is estimated that now about one-third of the molasses produced in Europe is used as forage for stock.

It is fed directly to cattle but usually diluted and absorbed on cut straw, hay and cereal waste or peat. In Louisiana and Texas when feeding molasses about 5 pounds per day is used for cattle, and about 12 pounds for mules This is mixed with the hay and grain or sprinkled on cane tops. The amount of the other feeds required is considerably diminished by the use of molasses.

MOLASSES FEEDS.

Molasses feeds are becoming very popular. They are made of various mixtures of grains, oat offal, refuse from flouring mills, ground corn stalks, finely ground hay, rice hulls, malt sprouts, brewers grains, distillers grains, cotton seed meal and similar products with 10 to 30 per cent of molasses. There are a great many low class of products in these mixtures and many times the molasses is used to conceal poor goods.

In manufacturing molasses feeds the simple mixing of the materials and molasses is not sufficient. Artificial drying must be resorted to. If these feeds are not dried sufficiently fermentation sets in and spoils the feed. This is more likely to happen in warm weather. A molasses feed should not carry over 10 to 12 per cent of molasses.

AMOUNT OF MOLASSES AVAILABLE.

The amount of molasses available for feeding purposes in the United States has increased considerably during recent years. The Census report for 1900 gives the yield from Cane Sugar as 16,505,119 gallons. There is no data recorded for the yield of beet molasses; but this source has increased greatly in the last few years and probably is at least one million gallons. Hawaii produces 4,416,631 gallons of molasses which has had practically no selling value whatever. In addition to the supplies produced in the United States considerable molasses now comes into the markets from Cuba and other nearby islands, and the product may, in fact, be considered available to our people as a source of supply for stock feeding.

MANUFACTURE OF CANE SUGAR AND MOLASSES.

The manufacture of raw sugar from the sugar cane takes place in four steps:

(a) Extraction of the juice—the leaves are stripped from the cane before it is brought in from the field. It is then brought to the mill and crushed to express the juice—an operation which must be done promptly in order to avoid losses by fermentation. The juice is caught in a trough beneath the mill and drawn off. The "begasse" or "trash" is burned under the boilers.

(b) Clarification. In addition to the bits of sugar-cane which are removed by straining, the juice contains organic acids, nitrogeneous bodies and invert sugar, which are easily susceptible to fermentation. These are removed by "defecation." The juice is passed into tanks warmed by steam coils, and treated with milk of lime until the acids are *almost* neutralized. This coagulates the albumin and part of the gummy matter, which is then skimmed off, leaving the filtrate or sugar solution ready for evaporation.

(c) Evaporation. The juice is generally concentrated in vacuum pans, which are usually arranged in series of three, until the solution contains about 50 per cent of solid matter, when it is transferred to a simple vacuum pan called the "strike pan" where the evaporation is slowly continued under high vacuum. The object being to build up crystals on the crystal points.

(d) Separation of the Crystals. When the grain has reached the desired size the mixture of crystals and syrup which is called "masse-cuite" is emptied into storage tanks, where it cools somewhat. It is then run into centrifugal machines, where the molasses is separated from the sugar. The latter is called the "First Sugar" and is at once packed for the market. The molasses thus obtained is called *first molasses* and contains 45 to 50 per cent of sugar which is not crystalizable. It is diluted and defecated with lime, as above, and the clarified syrup reboiled in vacuum pans to obtain a "Second Sugar." This forms very slowly. The mass is then centrifugated yielding a "second or molasses sugar" and "second molasses." This second molasses contains about 40 per cent of sugar which it does not pay to recover, and it is this molasses which is sometimes fermented for making alcohol or rum, and also used as a feed for cattle.

PREPARATION OF RAW SUGAR AND MOLASSES FROM BEETS.

The manufacture of sugar and molasses from beets, may be outlined as follows:

(a) Washing and slicing the beets. The beets are mechanically washed to remove the sand and loam which usually adheres to them and then cut into slices from 0.5 to 1.0 inch thick by a machine containing revolving knives.

(b) Extracting the juice. The juice is usually extracted from the sliced beets by the *diffusion process*. The slices are put into vertical iron cylinders and systematically digested with water at a temperature of 60°C. These digesters are arranged in batteries. The juice is removed and fresh water added until all but 0.5 per cent of the sugar is extracted.

(c) Clarifying. This is done in practically the same manner as in making the sugar cane.

(d) Evaporating. The evaporation is carried out in two stages, by the use of the triple vacuum pans and "strike pan" as in the preparation of cane sugar.

(e) Separating the crystals. The molasses is separated from the sugar by centrifugal machines as described under cane sugar. The sugar thus obtained closely resembles the first sugar from the sugar cane.

(f) Treating the molasses. The molasses is boiled down for a second sugar and second molasses as already described. The latter contains over 40 per cent of sugar which cannot be crystallized. This is now generally recovered by treating the molasses with quick-lime or strontium hydroxide in excess. A tricalcium sucrate $C_{12}H_{12}O_{11}$ 3 Ca O is formed which may be washed with alcohol to remove the new sugar substances; or it may be separated from the diluted syrup as a precipitate and filter pressed, leaving the impurities in solution. It is then powdered and mixed with water to form a paste; this is either used instead of lime for defecating the fresh juice or is decomposed by passing CO_2 into it. In either case, the lime precipitates leaving the sucrose in solution.

Beet sugar molasses contains a large amount of potassium salts, especially potassium sulphate, which prevent the crystallization of a part of the sugar content. These may be removed by adding aluminum sulphate, this forming alum with the potash salt. This may be separated by dialysis, the potash salts passing through the membrane and the sugar remaining. But sugar molasses also contains certain nitrogenous bodies (amides) which impart a very unpleasant odor and taste, rendering it unfit for table use. But it is nearly free from an invert sugar and glucose, for which reason large amounts of lime may be used in defecating, without injury to the sugar.

TABLE I.

Composition of various grades of Sugar Cane Molasses.

Yield, starting with 1,000,000 lbs. cane.*

	Lbs.	Total Solids	Sucrose	Dextrose	Levulose	Ash	Albuminoids	Amides, etc.	Acids, germs, etc.	
1st Molasses	64,500	80.00	44.80	11.40	10.80	4.50	.22	1.78	6.50	Poor Juice
2nd "	41,000	80.00	31.40	15.00	16.00	5.60	.30	2.40	9.30	" "
1st "	71,213	80.00	53.60	8.76	8.00	4.00	.20	.94	4.50	Average Juice
2nd "	42,563	80.00	41.70	12.20	12.50	5.35	.25	1.50	6.50	" "
1st "	54,563	80.00	58.90	6.00	5.80	4.70	.25	1.85	2.50	Good Juice
2nd "	24,269	80.00	39.70	11.40	12.00	8.00	.40	3.50	5.00	" "
3rd "	18,284	80.00	29.40	13.60	15.80	9.80	.43	3.97	7.00	" "

*By C. A. Brown, Jr., International Sugar Journal, July 1906, No. 91, Vol. 8, p. 364.

*COMPOSITION OF BEET SUGAR MOLASSES.

Sp. Gr.	Water	Sucrose	Invert Sugar	Nitrogen				Organic Non-sugar	Ash
				Total	Protein	Non-Protein	Nitric Acid		
1.412	22.50	51.45	.19	1.64	.12	1.52	.13	18.73	7.10

*From Konig-Chemie der nunschlicben Nahrungs Und Genuss Mitlel. S. 982-3- II Band.

TABLE II.

Composition of the Ash of Molasses from Different Sources.

	I.	II.	III.	IV.	V.
Potash K_2O	49.48	52.20	51.48	50.16	49.92
Soda Na_2O	0.89	0.80	1.11	0.32	9.24
Lime CaO	6.47	6.78	6.58	8.53	4.92
Magnesia MgO	4.29	3.09	3.99	2.66	0.15
Iron Oxide Fe_2O_3	0.35	0.33	0.15	0.47	0.48
Alumina Al_2O_3	0.30	0.22	0.13	0.30	....
Silica SiO_2	4.12	4.59	2.83	4.10	0.06
Phosphoric Acid P_2O_5	3.71	3.80	2.12	0.91	0.43
Sulphuric Acid SO_3	10.79	6.72	10.94	11.18	1.42
Carbonic Acid CO_2	7.49	11.19	13.06	15.78	28.51
Chlorine Cl	14.00	11.95	9.10	4.59	7.06
Total	101.89	101.67	101.49	99.00	102.19
Deduction $O=Cl$	3.16	2.70	2.05	1.04	1.60
	98.73	98.97	99.44	97.60	100.59
Undetermined (carbon, etc.)	1.27	1.03	.56	2.04	none
Alkalinity c. c. N/10 per grain ash.	80 c. c.	93 c. c.	95 c. c.	109 c. c.	....

Analyses I, II, III, IV are from a report read at International Congress of Applied Chemistry, held at Rome in 1906, and published by the author, Dr. C. A. Browne, Jr., in the International Sugar Journal, of Altringham, Manchester, England, July, 1906. Vol. 8. No. 91.

I. Mill Sulphitation.
II. Diffusion Sulphitation.
III. Open Kettle.
IV. Carbonatation.

These do not represent single analysis, but averages of many obtained by these different processes in the State of Louisiana.

No. V is an average of three samples by K. Hammer, as published in Cheim der nunschlichen Nahrungs und Genuss mittee von Dr. J. Konig. II. Band. S. 982-3.

PROPERTIES OF MOLASSES.

Molasses whether obtained from the sugar-cane or from beets probably owes its value as a feeding substance primarily to the sugar contained in it. As has been stated, beet sugar molasses contains a large amount of salts, particularly potassium salts—especially potassium sulphate, which prevents the crystallization of the sugar in the molasses. This molasses also contains more nitrogenous matter, amides, which impart an unpleasant odor and taste, and render it unfit for table use, but it is nearly free from invert sugar and glucose.

On the other hand, cane sugar molasses is nearly free from nitrogenous bodies, and hence the unpleasant taste and odor; but contains considerable amount of glucose and invert sugar.

Physiologically, it seems to be pretty generally admitted that in feeding molasses, one of the first results to be noted is that diarrhoea is apt to follow. Although it has been stated that this seems to be only a temporary disarrangement, and need cause no alarm. This will be further discussed in the course of the present work.

PLAN OF THE EXPERIMENTS.

The experiments conducted in the study of sugar feeds consisted in a study of the digestibility of the principal sugar feeds in the market, and the effects of molasses on the digestibility of hay and mixed grain rations. The experiments outlined were to include a study of effects of these feeds upon the quality and quantity of products, but the work on this portion of the investigations has been delayed so as to make it necessary to leave it for a report at some future time.

LIST OF TESTS MADE.

The following are the experiments conducted and reported upon in this bulletin.

I. A study of the effect of molasses on the digestibility of hay.

II. A study of the effect of molasses on the digestibility of a mixed grain ration.

III. A determination of the digestibility of sucrene dairy feed.

IV. A determination of the digestibility of Mueller's Molasses Grains.

V. Effects of molasses on Nitrogen Metabolism.

TIME AND DURATION OF EXPERIMENTS.

Period.	Steer No.	Preliminary Began. 1906.	Digestion Began.	Digestion Ended.	Ration.
I...	Steers 1 and 2.	Apr. 25, P. M.	May 7, A. M.	May 12, A. M.	Hay.
	" 4 and 4.	Apr. 30, P. M.	May 14, A. M.	May 19, A. M.	
II..	" 1 and 2.	May 12, P. M.	May 21, A. M.	May 26, A. M.	Hay and Sucrene.
	" 3 and 4.	May 19, P. M.	May 28, A. M.	June 2, A. M.	
III.	" 1 and 2.	May 26, P. M.	June 4, A. M.	June 9, A. M.	Hay and Grain.
	" 3 and 4.	June 2, P. M.	June 11, A. M.	June 16, A. M.	
IV.	" 1 and 2.	June 9, P. M.	June 18, A. M.	June 23, A. M.	Hay & Grain and Molasses.
	" 3 and 4.	June 16. A. M.	June 25, A. M.	June 30, A. M.	
V...	" 1 and 2.	June 23, P. M.	July 2, A. M..	July 7, A. M.	Hay & Mueller's Molasses Grain.
	" 3 and 4.	June 30, P. M.	July 9, A. M.	July 14, A. M.	
VI..	" 1 and 2.	July 7, P. M.	July 16, A. M	July 21, A. M.	Hay and Molasses.

It will be noted that each period consisted of a preliminary period of nine days and a digestion period of five days.

METHODS AND APPARATUS USED.

In the digestion experiments the dung and urine were collected and samples drawn daily from each, for analysis. The samples of dung were dried in the steam oven to the air dried state. The size of the sample dried out was in proportion to the total amount of excreta. Composit samples were made up from the daily samples for each steer for each period. The nitrogen in the urine was determined daily in fresh samples by the Kjeldahl method.

The animals were kept in the digestion apparatus described in Bulletin 43 (page 167) of the Station. The feeds were analyzed according to the methods of the Official Agricultural Chemists, except that the sugars were determined by Low's method which is as follows:

LOW'S VOLUMETRIC METHOD (MODIFIED).

For the determination of the Copper in the Cuprous Oxide Precipitate.

Standardization of the thiosulphate solution. Prepare a solution of sodium thiosulphate containing 19 grams of pure crystals to 1000c.c. Weigh accurately about 0.2 gram of pure copper foil and place in a flask of 250cc. capacity. Dissolve by warming with 5cc. of a mixture of equal volumes of strong nitric acid and water. Dilute to 50cc., boil to expel the red fumes, and add 5cc. of strong bromine water, and boil until the bromine is thoroughly expelled. Remove from the heat and add a slight excess of strong ammonia (7cc. is about the right amount). Again boil until the excess of ammonia is expelled, as shown by a change of color of the liquid, and a partial precipitation. Now add a slight excess of strong acetic acid (3 or 4cc. of 7 per cent acid) and boil for a minute. Cool to room temperature and add 10cc. of a solution of pure potassium iodide containing 300 grams of potassium to 1000cc. Titrate at once with the thiosulphate solution until the brown tinge has become weak, then add sufficient starch liquor to produce a marked blue coloration. The blue color changes toward the end to a faint lilac. If at this point the thiosulphate be added drop by drop and a little time be allowed for complete reaction after each addition there is no difficulty in determining the end point within a single drop. 1cc. of the thiosulphate will be found to correspond to about 0.005 gram of copper.

Determination of Copper. After washing the precipitated coprous oxide, cover the gooch with a watch glass and dissolve the oxide by means of 5cc. of warm nitric acid (1:1) poured under the watch glass with a pipette. Catch the filtrate in a flask of 250cc. capacity, wash watch glass and gooch free of copper (50cc. of water will be sufficient). Boil to expel the red fumes, add 5cc. of bromine water, boil off the bromine, and proceed exactly as in standardizing the thiosulphate.

ANIMALS USED.

The steers used in these experiments were grade short horns two years old. They were obtained from the Washington Stock Yards, to which place they had been shipped from Frederick County, Md. They were in fair flesh at time of purchase, and would have gone to the butcher had they not been purchased for this experiment. They were not in high flesh and would not have been termed ripe by the feeder.

No. 1 would be classed as a medium feeder.

No. 2 and No. 3 were not of as good a type as No. 1, but would have been termed fair.

No. 4 was an almost ideal type of steer for feeding.

They were quiet steers, easy to handle, had good appetites and at no time showed any discomfort or uneasiness and on the whole proved to be exceedingly well adapted to the work for which they were used.

FEEDS USED.

The feeds used will be discussed more in detail under the different experiments.

The composition of the feeds used and the dungs collected during the disgestion periods are given in the following tables:

TABLE V.

Composition of feeds used in the following experiments.

Anal. No.	Description	Moisture	Dry Substance	Ash	Nitrogen	Crude Protein	Ether Extract	Crude Fiber	N-Free Extract	Sugars Before Inv.	Sugars After Inv.
843	Hay. Period I................	10.04	89.96	4.28	1.24	7.72	2.43	32.73	42.80	2.32	3.06
866	Hay. Periods II-V..........	10.40	89.60	4.25	1.31	8.16	3.36	29.21	44.62	3.00	3.84
908	Hay. Periods II-V..........	12.08	87.92	4.37	1.22	7.63	5.78	30.28	39.86	0.64	1.18
xxx	Hay (Average)*.............	11.24	88.76	4.31	1.27	7.94	4.57	29.74	42.20	1.82	2.51
972	Hay. Period VI.............	12.29	87.71	3.84	1.21	7.55	2.27	31.57	42.48	0.76	1.27
973	Hay refused Steer No. 1, I-V.	11.66	88.34	4.67	0.90	5.62	2 22	33.91	41.92	1.44	2.95
974	Hay refused Steer No. 2, I-V.	10.17	89.93	4.12	0.72	4.48	5.45	33.38	42.40	2.10	3.59
975	Hay refused Steer No. 3, I-V.	11.78	88.22	4.35	1.09	6.77	2.78	35.33	38.99	1.27	2.24
976	Hay refused Steer No. 4, I-V.	15.76	84.24	5.62	0.98	6.11	2.51	34.44	35.56	0.24	2.19
978	Hay refused Steer No. 2, VI..	17.45	82.55	5.00	0.95	5.93	1.07	39.24	31.31	0.60	0.61
844	Sucrene......................	11.77	88.23	6.95	2.71	16.94	6.88	9.60	47.86	10.86	12.56
845	Wheat Bran	11.46	88.54	5.69	2.43	15.18	4.83	12.14	50.70	1.99	4.87
846	Gluten Feed..................	9.46	90.54	1.94	4.05	25.32	3.42	7.67	52.19	1.90	1.91
847	Cotton Seed Meal	8.28	91.72	5.88	6.92	43.26	9.10	9.53	23.95	none	4.92
848	Hominy Chop	8.29	91.71	2.55	1.45	9.04	7.14	10.27	62.71	1.60	2.69
849	Ground Oats.................	9.95	90.05	3.29	1.84	11 50	5.52	10.38	49.36	0.91	1.50
850	Mixed Feed..................	9.70	90.30	4.32	3.26	20.36	6.12	10.86	48.64	1.08	3.68
893	Mixed Feed..................	10.55	89.45	4.28	3.45	21.59	6.25	9.46	47.87	1.34	3.93
909	Molasses.....................	26.94	73.06	6.03	0.40	2.54	....	.....	64.49	20.33	53.44
952	Mueller's Molasses Grains....	21.65	78.35	5.14	3.06	19.13	3.13	8.17	42.78	19.02	20.96
959	Mueller's Molasses Grains....	21.68	78.32	5.11	2.85	17.82	2.50	8.17	44.82	19.54	22.60
000	Mueller's Molasses Grains.... Average two samples.†	21.67	78.33	5.12	2.96	18.50	2.82	8.17	43.72	19.28	21.78

*Average of Samples 866 and 908.
†Average of Samples 952 and 959.

TABLE VI.

Composition of Dungs Collected During Digestion Experiments.

(Per Cent.)

Anal. No.	Steer No.	Water.	Dry Substance.	Ash.	Nitrogen.	Crude Protein.	Crude Fibr.	Ether Extract.	N. Free Extract.	Sugars Before Inversion.	Sugars After Inversion.
					Period I.—Ration—Hay.						
829	1	83.30	16.70	1.34	0.19	1.19	5.85	0.51	7.81	0.135	0.116
830	2	80.78	19.22	1.52	0.26	1.59	6.22	0.67	9.22	0.285	0.299
831	3	79.85	20.15	1.61	0.27	1.69	6.47	0.75	9.63	0.163	0.169
832	4	80.47	19.53	1.53	0.24	1.52	6.54	0.71	9.23	0.187	0.202
					Period II.—Ration—Hay + Sucrene.						
864	1	81.12	18.88	2.09	0.40	2.50	5.30	0.74	8.26	0.181	0.226
865	2	77.58	22.42	2.61	0.56	3.50	5.11	0.85	10.35	0.251	0.275
867	3	79.97	20.03	2.32	0.45	2.81	5.14	0.70	9.06	0.108	0.142
868	4	80.13	19.87	1.88	0.42	2.63	5.84	0.65	8.87	0.108	0.109
					Period III.—Ration—Hay + Mixed Grain Feed.						
879	1	77.07	22.93	2.20	0.46	2.89	7.55	0.83	9.46	0.088	0.058
880	2	81.15	18.85	1.85	0.43	2.68	5.71	0.79	7.82	0.063	0.039
904	3	79.57	20.43	2.03	0.47	2.94	5.41	0.85	9.20	0.065	0.038
905	4	83.63	16.37	1.49	0.31	1.94	5.36	0.59	6.99	0.038	0.027
					Period IV.—Ration—Hay + Mixed Grain Feed + Molasses.						
920	1	82.21	17.79	1.87	0.42	2.63	5.13	0.58	7.58	0.115	0.082
921	2	81.77	18.23	1.83	0.45	2.81	5.23	0.66	7.70	0.053	0.090
953	3	83.59	16.41	1.73	0.49	3.06	4.68	0.58	6.36	0.146	0.060
954	4	85.23	14.77	1.53	0.41	2.56	4.27	0.48	5.93	0.100	0.102
					Period V.—Ration—Hay + Mueller's Molasses Grains.						
955	1	85.61	14.39	1.48	0.39	2.44	3.99	0.50	5.98	0.133	0.071
956	2	83.07	16.93	1.69	0.48	3.00	4.79	0.56	6.89	0.063	0.074
957	3	83.73	16.27	1.60	0.48	3.00	5.22	0.55	5.90	0.130	0.100
958	4	84.14	15.86	1.55	0.47	2.94	4.85	0.59	5.94	0.109	0.097
					Period VI.—Ration—Hay + Molasses.						
970	1	83.12	16.88	1.70	0.30	1.90	5.82	0.64	6.82	0.106	0.112
971	2	80.17	19.83	1.99	0.38	2.38	6.69	0.78	7.99	0.120	0.112

WEIGHTS OF ANIMALS.

In feeding in work of this sort the main object is to give such amounts as would represent a full feed for animals doing a given work. The feeds used being principally of interest to dairymen were fed in amounts that would be about equal to a dairy ration.

TABLE VII.

Weights of Steers during Experiments.

Period	Steer No.	Weight at Beginning of Preliminary Period	Weight at Beginning of Digestion Period	Weight at End of Digestion Period	Ration
I. .	Steer 1.......	....	1221	1148	Hay
	Steer 2.......	....	1047	992	
	Steer 3.......	1103	1118	1089	
	Steer 4.......	1132	1160	1137	
II. .	Steer 1......	1148	1222	1207	Hay and Sucrene
	Steer 2.......	992	1076	1077	
	Steer 3.......	1089	1168	1148	
	Steer 4.......	1137	1226	1235	
III.	Steer 1.......	1207	1272	1245	Hay and Mixed Grain
	Steer 2.......	1077	1131	1148	
	Steer 3.......	1148	1155	1156	
	Steer 4.......	1235.	1260	1265	
IV.	Steer 1.......	1245	1301	1319	Hay and Mixed Grain and Molasses
	Steer 2.......	1148	1183	1185	
	Steer 3.......	1156	1183	1150	
	Steer 4.......	1265	1282	1280	
V. .	Steer 1.......	1319	1311	1315	Hay and Mueller's Molasses Grain
	Steer 2.......	1185	1167	1188	
	Steer 3.......	1150	1193	1219	
	Steer 4.......	1280	1273	1281	
VI .	Steer 1.......	1315	1364	1246	Hay and Molasses
	Steer 2.......	1188	1127	1116	

It will be noted that on the whole the animals made slight gains.

I. THE EFFECT OF MOLASSES ON THE DIGESTIBILITY OF HAY.

The digestion coefficient of the hay was obtained, as this was the common factor and represented the roughage fed during all of the periods. It was planned to have the hay and the molasses periods follow one another, but through delays in transit the molasses did not reach us in time and thus caused the period of adding it to the hay to be deferred until the end and then could only be carried through with two steers.

The molasses used in this experiment was a very dark, heavy grade which was advertised in the agriculture papers and being placed on the market especially for stock feeding by J. S. Sills & Sons, of New York City. This molasses was diluted with an equal weight of water and sprinkled over the hay previous to feeding. The molasses was fed in small quantities at first and gradually increased. The animals seemed to like the molasses from the first and it seemed to agree with them very well. The hay used was a good quality of mixed timothy and clover with the timothy predominating.

The details of the amounts of food consumed during the two periods are given in tables 8 and 10, and the data from which the digestion coefficients were obtained are given in tables 9 and 11.

TABLE VIII.

Showing Consumption of Hay and Water during Digestion Period I.
Hay Eaten and Water Drunk.
(Weight in Grams.)

PORTION OF PERIOD.	No. Days.	HAY EATEN.		WATER DRUNK.	
		Total.	Average Per Day.	Total.	Average Per Day.
Steer No. 1.					
Preliminary	12	93270	7773	359110	29926
Digestion	5	24220	4844	91760	18352
Steer No. 2.					
Preliminary	12	58080	4840	213650	17804
Digestion	5	18750	3750	56190	11238
Steer No. 3.					
Preliminary	14	95570	6826	319430	22816
Digestion	5	29960	5992	90290	18058
Steer No. 4.					
Preliminary	14	96140	6867	334690	23906
Digestion	5	29700	5940	91450	18290

TABLE IX.

Showing Digestibility of the Components of Mixed Hay—Digestion Period 1—Length of Preliminary Period 12 days, and Digestion Period 5 days.

(Weight in grams—453.6=1 pound.)

	Anal. No.	Fresh Substance	Dry Substance	Ash	Nitrogen	Crude Protein	Crude Fiber	Ether Extract	N-Free Extract	Sugars before Inv.	Sugars after Inv.
Steer No. 1											
Hay Fed	.....	26000.1	23389.6	1112.8	322.4	2015.0	8509.8	631.8	11120.2	603.2	795.6
Hay Refused	973	1780.1	1572.5	83.1	16.0	100.0	603.6	39.5	746.3	25.6	52.5
Total Eaten	.....	24220.1	21817.1	1029.7	306.4	1915.0	7906.1	592.3	10373.9	537.6	748.1
Total Excreted	829	82870.1	13839.3	1110.5	157.5	984.4	4848.0	422.6	6473.8	111.9	96.1
Digested	.....	....	7977.8	80.8	148.9	930.6	3058.2	170.7	3900.1	425.7	647.0
Per Cent. Digested	.....	....	36.56	....	48.60	48.60	38.68	28.82	37.62	79.18	87.06
Steer No. 2											
Hay Fed	.....	19000.0	17092.4	813.4	235.6	1472.5	6218.5	461.9	8126.1	440.8	581.4
Hay Refused	974	250.0	224.7	10.3	1.8	11.2	83.6	13.6	106.0	5.3	9.0
Total Eaten	.....	18750.0	16867.7	803.1	233.8	1461.3	6134.9	448.3	8020.1	435.5	572.4
Total Excreted	.....	48680.0	9356.3	739.8	126.5	790.6	3025.0	326.1	4474.8	138.7	145.6
Digested	.....	....	7511.4	63.3	107.3	670.7	3109.9	122.2	3545.3	296.8	426.8
Per Cent. Digested	.....	....	44.54	7.88	46.00	46.00	50.70	27.21	44.21	68.16	74.56
Steer No. 3											
Hay Fed	.....	30000.0	26988.0	1284.0	372.0	2325.0	9819.0	729.0	12831.0	696.0	918.0
Hay Refused	975	40.0	35.3	1.7	.4	2.5	14.1	1.1	15.9	.5	.9
Total Eaten	.....	29960.0	26952.7	1282.3	371.6	2322.5	9804.9	727.9	12815.1	695.5	917.1
Total Excreted	831	65100.0	13117.7	1048.0	175.7	1098.1	4211.5	488.2	6271.9	106.0	110.0
Digested	.....	....	13835.0	234.3	195.5	1224.4	5593.4	239.7	6543.2	589.5	807.1
Per Cent. Digested	.....	....	51.34	18.27	52.72	52.72	57.04	32.93	51.05	84.76	88.01
Steer No. 4											
Hay Fed	.....	30000.0	26988.0	1284.0	372.0	2325.0	9819.0	729.0	12831.0	696.0	918.0
Hay Refused	976	300.0	252.7	16.9	2.9	18.1	103.3	7.5	106.9	.7	6.6
Total Eaten	.....	29700.0	26735.3	1267.1	369.1	2306.9	9715.7	721.5	12724.1	695.3	911.4
Total Excreted	832	61630.0	12036.3	942.8	147.8	936.7	4030.5	437.5	5688.8	115.3	124.5
Digested	.....	....	14699.0	324.3	221.3	1370.2	5685.2	284.0	7035.3	580.0	786.9
Per Cent. Digested	.....	....	54.98	25.59	59.96	59.96	58.58	39.36	55.29	83.42	86.33
Average for 4 Steers	.....	....	48.35	17.25	44.32	44.32	51.25	32.08	47.04	78.88	83.89

TABLE X.

Showing Consumption of Hay and Molasses during Digestion, Period VI. Food Eaten and Water Drunk.

(Weight in Grams,)

PORTION OF PERIOD.	No. Days.	HAY EATEN.		MOLASSES EATEN.		WATER DRUNK.	
		Total.	Average Per Day.	Total.	Average Per Day.	Total.	Average Per Day.
Steer No. 1.							
Preliminary.....	9	44000	4889	9000	1000	194780	21642
Digestion.......	5	25000	5000	5000	1000	101070	20214
Steer No. 2.							
Preliminary	9	40172	4464	9000	1000	154890	17210
Digestion.......	5	24675	4935	5000	1000	85090	17018

TABLE XI.

Showing Digestibility of Hay and Molasses. Digestion Period VI. Length of Preliminary Period 9 Days and Digestion Period 5 Days.

(Weight in grams—453.6 grams=1 pound.)

	Anal. No.	Fresh Substance.	Dry Substance.	Ash.	Nitrogen.	Crude Protein.	Crude Fiber.	Ether Extract.	N-Free Extract.	Sugars Before Inv.	Sugars After Inv.
Steer No. 1.											
Hay eaten..................	xxx	25000.0	21925.0	960.0	302.5	1890.0	7892.0	567.5	10615.5	190.0	317.5
Molasses eaten.............	909	5000.0	3653.0	301.5	20.0	125.0	....	....	....	1016.5	2672.0
Total eaten................	......	30000.0	25578.0	1261.5	322.5	2015.0	7892.0	567.5	10615.5	1206.5	2989.5
Total excreted.............	970	62540.0	10557.0	1063.0	187.6	1172.5	3640.0	400.5	4281.0	66.3	70.0
Digested...................	......	....	15021.0	198.5	134.9	842.5	4252.0	167.0	6334.5	1140.2	2919.5
Per cent. digested.........	......	....	58.73	15.74	41.83	41.83	53.88	29.43	59.68	94.67	97.66
Steer No. 2.											
Hay fed....................	xxx	25000.0	21925.0	960.0	302.5	1890.6	7892.0	567.5	10616.9	190.0	317.5
Molasses...................	909	5000.0	3653.0	301.5	20.0	125.0	....	....	3226.5	1016.5	2672.0
Total fed..................	......	30000.0	25578.0	1261.5	322.5	2015.6	7892.0	567.5	13843.4	1206.5	2989.5
Hay and Molasses refused..	978	390.0	321.9	19.5	3.7	23.1	153.0	3.0	123.3	2.3	2.7
Total eaten................	......	29610.0	25256.1	1242.0	318.8	1992.5	7739.0	564.5	13720.1	1204.2	2986.8
Total excreted.............	971	54470.0	10822.0	1084.0	207.0	1293.8	3644.0	424.8	4352.0	65.4	61.0
Total digested.............	......	....	14434.1	158.0	111.8	698.7	4095.0	139.7	9368.1	1138.8	2925.8
Per cent. digested.........	......	....	56.64	12.52	34.67	34.67	51.90	24.62	67.68	94.59	97.87
Average for 2 steers.......	......	....	57.58	14.13	38.25	38.25	52.89	27.02	63.68	94.63	97.76

Bringing the above results together for comparison we have,

TABLE XII.

Digestibility of the Components of Hay.

(Per Cent.)

	Dry Substance	Ash	Crude Protein	Crude Fiber	N-Free Extract	Fat	Sugar before Inv.	Sugar after Inv.
Hay (average for 4 steers)..	48.4	17.2	44.3	51.3	47.0	32.1	78.9	84.0
Hay (average for 2 steers)..	40.6	3.9	47 3	44.7	40.9	28.0	73.7	80.8
Hay and Molasses (average for 2 steers)............	57.6	14.1	38.3	52.9	63.7	27.0	94.6	97.7
Effect of Molasses..........	+17.0	+10.2	−9.0	+8.2	+22.8	−1.0	+20.9	+16.9

From the above figures when studied in connection with those in table 11 it will be noticed that the general effect of the molasses was to increase the digestibility of the hay. The most marked effect seemed to be upon the starch and sugar compounds of the hay, and it is probable that the salts in the molasses and the ferments which it introduced exerted a marked influence in breaking up the more staple Nitrogen-free extract compounds in the hay.

If we assume that all of the dry substance of the molasses was digestible it would still allow about one-third of the increase to be credited to the greater digestibility of the hay as caused by the presence of the molasses. This was produced by the consumption of about 2 lbs. of molasses per day, or at a cost of about 2 cents.

II. THE EFFECT OF MOLASSES ON A MIXED GRAIN RATION.

So far as the composition of the molasses feeds on the market are advertised or known, they are made up of a variety of grains and mostly of those which are relatively rich in protein. With a view of using a mixture that might somewhat imitate those on the market and at least represent the feeds most commonly in use by dairymen, the following mixture of grain was made up for periods III and IV.

Wheat Bran	200 lbs.
Gluten Feed	120 "
Cotton Seed Meal	180 "
Hominy Chop	50 "
Ground Oats	200 "
Total	750 "

This was made up in two lots. Mixture (sample) No. 850 was fed with the hay during period III. as an insufficient quantity was made up to last for the two periods, another lot was mixed up in the same proportions (sample No. 193), and fed during period IV. The two analyses as given in table No. 5 will show that there was no material difference in the two mixtures. In period IV molasses was mixed with the grain just previous to feeding. The quantity of molasses fed each time was just one-third the weight of the grain or one-fourth or 25 per cent of the total. Thus the ration for this period imitated a molasses feed containing 25 per cent of molasses. The hay used during these periods was the same as fed during period I. It was aimed to feed the same quantity but the animals failed to eat quite as much after the grain was added to the ration.

The details of the amounts of food consumed during period III. and IV. will be found in tables 13 and 15, and the data from which the digestion coefficients are obtained are given in tables 14 and 16.

TABLE XIII.

Showing Consumption of Hay, Grain and Water during Digestion Period III.

(Food eaten and water drunk.)

Digestion of Period	No. Days	HAY EATEN		GRAIN EATEN		WATER DRUNK	
		Total	Average Per Day	Total	Average Per Day	Total	Average Per Day
Steer No. 1							
Preliminary..	9	28900	3211	54000	6000	370520	41169
Digestion....	5	20830	4166	30000	6000	207950	41590
Steer No. 2							
Preliminary..	9	34700	3864	54000	6000	252220	28024
Digestion....	5	19790	3958	30000	6000	177710	35542
Steer No. 3							
Preliminary..	9	35750	3972	54000	6000	306770	34086
Digestion....	5	19910	3982	30000	6000	153060	30612
Steer No. 4							
Preliminary..	9	48900	5433	54000	6000	370520	41169
Digestion....	5	20830	4166	30000	6000	207950	41590

TABLE XIV.

Showing Digestibility of Mixed Grain Ration. Digestion Period III. Length of Preliminary Period 9 days, and Digestion Period 5 days.

(Weight in grams—453.6 grams=1 pound.)

	Anal. No.	Fresh Substance	Dry Substance	Ash	Nitrogen	Crude Protein	Crude Fiber	Ether Extract	N-Free Extract	Sugars before Inv.	Sugars after Inv.
Steer No. 1											
Hay Fed	......	21000.0	18640.0	905.1	266.7	1666.9	6245.0	959.7	8863.3	487.2	527.1
Hay Refused	973	170.0	150.2	8.0	1.5	9.6	57.6	3.8	71.2	2.4	5.0
Hay Eaten	......	20830.0	18489.8	897.1	265.2	1657.3	6187.4	955.9	8792.1	484.8	522.1
Grain Eaten	850	30000.0	27090.0	1296.0	978.0	6112.5	3258.0	1836.0	13587.5	324.0	1104.0
Total Eaten	......	50830.0	45579.8	2193.1	1243.2	7769.8	9445.4	2791.9	22379.6	808.8	1626.1
Total Excreted	879	115800.0	26552.9	2547.5	532.7	3329.4	8742.0	961.1	10972.9	102.8	67.2
Total Digested	......	....	19026.9	none	710.5	4440.4	703.4	1830.8	11406.7	706.0	1558.9
Hay Digested	......	....	6759.9	....	128.9	805.4	2393.2	276.0	3308.0	383.8	454.5
Grain Digested	......	....	12267.0	none	581.6	3635.0	none	1554.8	8098.7	322.2	1104.4
Per Cent. Digested	......	....	45.28	none	59.36	59.36	none	84.64	59.60	99.4	100.0
Steer No. 2											
Hay Fed	......	20000.0	17752.0	862.0	254.0	1587.5	5948.0	914.0	8440.5	364.0	502.0
Hay Refused	974	210.0	188.8	8.7	1.5	9.5	70.1	11.4	89.1	4.4	7.5
Hay Eaten	......	19790.0	17563.2	854.3	252.2	1578.0	5877.9	902.6	8351.4	359.6	494.5
Grain Eaten	850	30000.0	27090.0	1296.0	978.0	6112.5	3258.0	1836.0	13587.5	324.0	1104.0
Total Eaten	......	49790.0	44653.2	2150.3	1230.5	7690.5	9135.9	2838.6	21938.9	683.6	1598.5
Total Excreted	880	91390.0	17225.0	1690.6	392.9	2455.6	5218.0	722.0	7138.8	57.6	35.6
Total Digested	......	....	27428.2	459.7	837.6	5234.9	3917.9	2116.6	14800.1	626.0	1562.9
Hay Digested	......	....	7820.0	67.3	116.2	725.9	2980.0	246.0	3692.0	245.1	368.7
Grain Digested	......	....	19608.2	392.4	721.4	4409.0	837.9	1870.6	11108.1	380.9	1194.2
Per Cent. Digested	......	....	72.38	30.28	73.76	73.76	28.79	101.89	86.60	117.5	108.2

Steer No. 3											
Hay Fed	......	20000.0	17752.0	862.0	254.0	1587.5	5948.0	914.0	8440.5	364.0	502.0
Hay Refused	975	90.0	79.4	3.9	1.0	6.2	31.8	2.5	35.0	1.1	2.0
Hay Eaten	......	19910.0	17672.6	858.1	253.0	1581.3	5916.2	911.5	8405.5	362.9	500.0
Grain Eaten	850	30000.0	27090.0	1296.0	978.0	6112.5	3258.0	1836.0	13587.5	324.0	1104.0
Total Eaten	......	49910.0	44762.6	2154.1	1231.0	7693.8	9174.2	2747.5	21993.0	686.9	1604.4
Total Excreted	904	83950.0	17151.0	1704.0	394.5	2465.6	4541.5	713.6	7726.3	54.6	31.9
Total Digested	.....	....	27611.6	450.1	835.5	5228.2	4632.7	2033.9	14266.7	632.3	1572.1
Hay Digested	.....	....	9073.0	156.8	133.4	833.6	3374.7	300.2	4290.5	307.6	440.0
Grain Digested	.....	....	18538.6	293.3	702.1	4394.6	1258.0	1733.7	9976.2	324.7	1132.1
Per Cent. Digested	.....	....	68.44	22.63	71.79	71.79	38.62	94.42	73.43	100.2	102.5
Steer No. 4											
Hay Fed	......	21000.0	18640.0	905.1	266.7	1666.9	6245.0	959.7	8863.3	487.2	527.1
Hay Refused	976	170.0	143.3	9.6	1.7	10.6	58.6	4.3	60.2	.4	3.7
Hay Eaten	......	20830.0	18496.7	895.5	265.0	1656.3	6186.4	955.4	8803.1	486.8	523.4
Grain Eaten	850	30000.0	27090.0	1296.0	978.0	6112.5	3258.0	1836.0	13587.5	324.0	1104.0
Total Eaten	......	50830.0	45586.7	2191.5	1243.0	7767.8	9444.4	2791.4	22390.6	810.8	1627.4
Total Excreted	905	116610.0	19088.3	1737.5	361.5	2259.4	6250.0	688.0	8153.5	44.3	31.5
Total Digested	.....	....	25498.4	454.0	881.5	5509.4	3194.4	2103.4	14237.2	766.5	1595.9
Hay Digested	.....	....	10169.0	202.3	158.9	992.8	3624.0	376.1	4866.0	406.2	451.9
Grain Digested	.....	....	15329.4	251.7	622.6	4517.6	none	1727.3	9371.2	360.3	1144.0
Per Cent. Digested	.....	....	73.74	19.44	63.66	63.66	none	94.08	68.98	111.2	103.6
Average for 4 steers	......	....	64.96	18.09	67.15	67.15	16.85	93.26	72.15	107.1	103.6

TABLE XV.

Showing Consumption of Hay, Grain, Molasses and Water during Digestion Period IV.

(Food eaten and water drunk.)

Portion of Period	No. Days	HAY EATEN		GRAIN EATEN		MOLASSES EATEN		WATER DRUNK	
		Total	Average Per Day	Total	Average Per Day	Total	Average Per Day	Total	Average Per Day
Steer No. 1									
Preliminary	9	40350	4483	54000	6000	12500	1389	342870	38097
Digestion..........	5	19620	3924	30000	6000	10000	2000	188620	37724
Steer No. 2									
Preliminary	9	35610	3957	54000	6000	12500	1389	294890	32766
Digestion..........	5	19790	3958	30000	6000	10000	2000	170080	34016
Steer No. 3									
Preliminary	9	34690	3854	54000	6000	14150	1572	297180	33030
Digestion..........	5	15180	3036	30000	6000	10000	2000	169880	33976
Steer No. 4									
Preliminary	9	44440	4938	54000	6000	14150	1461	363290	40366
Digestion..........	5	19880	3976	30000	6000	10000	2000	184300	36860

TABLE XVI.

Showing the Digestibility of Mixed Grain Ration and Molasses. Digestion Period IV—Length of Preliminary Period 9 days and the Digestion Period 5 days.

(Weight in grams — 453.6 grams = 1 pound.)

	Anal. No.	Fresh Substance	Dry Substance	Ash	Nitrogen	Crude Protein	Crude Fiber	Ether Extract	N-Free Extract	Sugars before Inv.	Sugars after Inv.
Steer No. 1											
Hay Fed	xxx	20000.0	17552.0	862.0	254.0	1587.0	5948.0	914.0	8440.5	364.0	502.0
Hay Refused	973	380.0	335.7	17.7	3.4	21.3	128.8	8.4	159.5	5.5	11.2
Hay Eaten	.....	19620.0	17416.3	844.3	250.6	1566.2	5819.2	905.6	8281.0	358.5	490.8
Grain Eaten	893	30000.0	26835.0	1284.0	1035.0	6468.8	2838.0	1875.0	14869.2	402.0	1179.0
Molasses	909	10000.0	7306.0	603.0	40.0	250.0	....	....	6449.0	2033.0	5344.0
Total Eaten	.....	59620.0	51557.3	2731.8	1325.6	8284.0	8657.2	2780.6	29099.2	2793.5	8013.8
Total Excreted	920	96800.0	17221.0	1810.0	406.5	2540.6	4965.6	561.4	7343.4	111.3	79.8
Total Digested	....	....	34336.3	921.3	919.1	5743.4	3691.6	2219.2	21755.8	2682.2	6934.5
Hay Digested	....	....	6367.0	....	120.8	761.3	2251.0	261.0	3115.5	283.9	427.6
Grain and Molasses Digested	.....	....	27969.3	921.3	798.3	4982.1	1440.6	1958.2	18640.3	2398.3	6506.9
Grain and Molasses Eaten	.....	40000.0	34141.0	1887.0	1075.0	6718.8	2338.0	1875.0	20818.2	2435.0	6523.0
Per Cent. Digested	.....	....	81.92	48.83	74.23	74.23	61.59	104.42	89.54	98.5	99.7
Steer No. 2											
Hay Fed	xxx	20000.0	17752.0	862.0	254.0	1587.5	5948.0	914.0	8440.5	364.0	502.0
Hay Refused	974	210.0	188.8	8.7	1.5	9.4	70.1	11.4	89.2	4.4	7.5
Hay Eaten	.....	19790.0	17563.2	853.3	252.5	1576.1	5877.9	902.6	8351.3	359.6	494.5
Grain Eaten	893	30000.0	26835.0	1284.0	1035.0	6468.8	2838.0	1875.0	14369.2	402.0	1179.0
Molasses	909	10000.0	7306.0	608.0	40.0	250.0	....	....	6449.0	2033.0	5344.0
Total Eaten	.....	59790.0	51704.2	2740.3	1327.5	8294.9	8715.9	2777.6	29169.5	2794.6	7017.5
Total Excreted	921	96180.0	17534.0	1760.0	432.8	2705.5	5030.0	634.8	7404.2	51.0	86.6
Total Digested	....	....	34170.2	980.3	894.7	5589.9	3685.9	2142.8	21765.3	2743.6	6930.9
Hay Digested	....	....	7822.0	67.2	116.2	726.3	2980.0	245.6	3692.0	245.1	368.7
Grain and Molasses Digested	....	....	26348.2	913.1	778.5	4863.6	705.9	1897.2	18073.3	2498.5	6562.2
Grain and Molasses Eaten	....	....	34141.0	1887.0	1075.0	6918.8	2338.0	1875.0	20813.2	2435.0	6523.0
Per Cent. Digested	....	....	77.18	48.39	72.42	72.42	30.19	101.18	86.82	102.6	100.6

TABLE XVI.—CONTINUED.

Showing the Digestibility of Mixed Grain Ration and Molasses. Digestion Period IV—Length of Preliminary Period 9 days and the Digestion Period 5 days.

(Weight in grams—453.6 grams=1 pound.)

	Anal. No.	Fresh Substance	Dry Substance	Ash	Nitrogen	Crude Protein	Crude Fiber	Ether Extract	N-Free Extract	Sugars before Inv.	Sugars after Inv.
Steer No. 3											
Hay Fed	xxx	17000.0	15088.0	732.6	215.9	1349.2	5054.0	776.8	7175.4	309.4	426.7
Hay Refused	975	1820.0	1605.9	79.2	19.8	123.7	643.0	50.6	709.4	23.1	40.8
Hay Eaten	.....	15180.0	13482.1	663.4	196.1	1225.5	4411.0	726.2	6466.0	286.3	385.9
Grain Eaten	893	30000.0	26835.0	1284.0	1035.0	6468.8	2838.0	1875.0	14369.2	402.0	1179.0
Molasses Eaten	909	10000.0	7306.0	603.0	40.0	250.0	....	....	6449.0	2033.0	5344.0
Total Eaten	.....	55180.0	47623.1	2550.4	1271.1	7943.3	7240.0	2601.2	27284.2	2721.3	6908.9
Total Excreted	953	94290.0	15472.0	1631.0	462.0	2887.5	4412.5	546.9	5994.1	137.7	56.6
Total Digested	.....	....	32151.1	919.4	809.1	5055.8	2836.5	2054.3	21290.1	2583.6	6852.3
Hay Digested	.....	....	6291.7	121.2	103.4	646.3	2516.0	239.0	3300.9	242.6	339.6
Grain and Molasses Digested	.....	....	25229.4	798.2	705.7	4409.5	320.5	1815.3	17989.2	2341.0	6512.7
Grain and Molasses Eaten	.....	....	34141.0	1887.0	1075.0	6718.8	3338.0	1875.0	20818.2	2435.0	6523.0
Per Cent. Digested	.....	....	73.90	42.30	65.65	65.65	13.71	96.82	86.42	96.1	99.8
Steer No. 4											
Hay Fed	xxx	20000.0	17752.0	862.0	254.0	1587.5	5948.0	914.0	8440.5	364.0	502.0
Hay Refused	976	120.0	101.1	6.7	1.2	7.3	41.3	3.0	42.8	.8	2.6
Hay Eaten	.....	19880.0	17650.9	855.3	252.8	1580.2	5906.7	911.0	8397.7	363.7	499.4
Grain Eaten	893	30000.0	26835.0	1284.0	1035.0	6468.8	2838.0	1875.0	14369.2	402.0	1179.0
Molasses Eaten	909	10000.0	7306.0	603.0	40.0	250.0	....	....	6449.0	2033.0	5344.0
Total Eaten	.....	59880.0	51791.9	2742.3	1327.8	8298.0	8744.7	2786.0	29215.9	2798.7	7022.4
Total Excreted	954	93410.0	13807.0	1429.0	383.0	2393.8	3988.5	448.3	5547.4	93.4	95.3
Total Digested	.....	....	37984.9	1313.3	944.8	5904.2	4756.2	2337.7	23668.5	2705.3	6927.1
Hay Digested	.....	....	9704.5	218.9	151.6	947.5	3460.1	358.6	4643.1	303.4	431.1
Grain and Molasses Digested	.....	....	28280.4	1094.4	793.2	4956.7	1296.1	1979.1	19025.4	2401.9	6496.0
Grain and Molasses Eaten	.....	....	34141.0	1887.7	1075.0	6718.8	2338.0	1875.0	20818.2	2435.0	6523.0
Per Cent. Digested	.....	....	82.84	58.00	73.79	73.79	55.44	105.55	91.89	98.6	99.6
Average for 4 steers	.....	....	78.96	49.38	71.52	71.52	40.23	101.99	88.55	98.9	99.9

Bringing the above results together for comparison we have these set forth in table 17.

TABLE XVII.

Digestibility of Mixed Grain Ration with and without Molasses.
(Average of results with 4 steers in per cents.)

	Dry Substance	Ash	Crude Protein	Crude Fiber	N-Free Extract	Fat	Sugar before Inv.	Sugar after Inv.
Mixed Grain..............	64.9	18.1	67.1	16.8	72.1	93.3	107.1	103.6
Mixed Grain and Molasses	78.9	49.4	71.5	40.2	88.6	102.0	98.9	99.9
Gain produced by Molasses	14.0	31.3	4.4	23.4	15.5	—8.7	......	......

The above results would seem to indicate that the molasses exerted a beneficial influence and caused an increase in the digestibility of the grains.

The instances where the digestion coefficients run over 100 of course represent an impossibility and may be due to several causes or a combination of them. A portion is due no doubt to oxidation products in the dung, which do not exist in the feeds; again, several feeds when brought together often contribute towards the digestibility of each other and thus the hay was probably more digestible in the presence of the grain than when fed alone. Some of the difference is also probably due to the method of analysis not being adapted to the dungs.

When considered as to the increased digestibility of the total dry matter the results agree fairly closely with those obtained for hay and was produced at about the same cost.

III. THE DIGESTIBILITY OF "SUCRENE" DAIRY FEED.

Sucrene dairy feed is probably more extensively used than any other molasses feed on the market. It is manufactured by some patented process which claims to convert the molasses into a sugar or a sugar-like substance. The base of the feed is made up of a mixture of a variety of grains.

"Sucrene" is generally much liked by animals but occasionally they do not seem to find it palatable at first; but by commencing to feed it in small quantities and gradually increasing the amount it is but a short time until the animals acquire the taste and become quite fond of it.

Sucrene represents a distinct class of molasses feeds in that it is much drier than most others, is not much inclined to cake and it also has good keeping qualities. The sucrene used in this experiment represented two lots, one bought from a carload shipped to Hyattsville Station, and a second lot bought through the Washington dealers in this feed.

After the completion of the digestion experiments sucrene was fed for some time to the steers and they continued to eat a full ration of it with relish, did well on it and showed no bad effects whatever.

The details of the amounts of food consumed and the results of the determination of the digestibility are set forth in tables No. 18 and No. 19.

TABLE XVIII.

Showing Consumption of Hay, Sucrene and Water during Digestion Period II.

(Rations eaten and water drunk.)

Portion of Period	No. Days	HAY EATEN		SUCRENE EATEN		WATER DRUNK	
		Total	Average Per Day	Total	Average Per Day	Total	Average Per Day
Steer No. 1							
Preliminary	9	38450	4272	54000	6000	310040	34449
Digestion	5	19880	3976	30000	6000	158180	31636
Steer No. 2							
Preliminary	9	15300	1700	54000	6000	207970	23108
Digestion	5	9870	1974	30000	6000	93110	18622
Steer No. 3							
Preliminary	9	46360	5151	52000	5778	271410	30157
Digestion	5	22850	4570	30000	6000	161120	32424
Steer No. 4							
Preliminary	9	47610	5290	54000	6000	337170	37463
Digestion	5	26000	5200	30000	6000	182440	36488

TABLE XIX.

Showing Digestibility of Sucrene. Period II—Length of Preliminary Period 9 days, and Digestion Period 5 days.
(Weight in grams—453.6 grams = 1 pound.)

	Anal. No.	Fresh Substance	Dry Substance	Ash	Nitrogen	Crude Protein	Crude Fiber	Ether Extract	N-Free Extract	Sugars before Inv.	Sugars after Inv.
Steer No. 1											
Hay Fed	xxx	20000.0	17752.0	862.0	254.0	1588.0	5948.0	914.0	8440.0	364.0	502.0
Hay Refused	973	120.0	106.0	5.6	1.1	6.7	40.7	2.7	50.3	1.7	3.5
Hay Eaten	......	19880.0	17646.0	856.4	252.9	1581.3	5907.3	911.3	8389.7	362.3	498.5
Sucrene Eaten	844	30000.0	26460.0	2085.0	813.0	4981.3	2880.0	2064.0	14458.7	3258.0	3768.0
Total Eaten	......	49880.0	44115 0	2941.4	1065.9	6562.6	8787.3	2975.3	22848.4	3620 3	4266.5
Total Excreted	864	100020.0	18885.0	2090.5	400.0	2500.0	5300.0	740.0	8260.0	181.0	226.0
Digested	......	....	25230.0	850.9	665.9	4062.6	3487.3	2235.3	14588.4	3439.3	4040.5
Hay Digested	......	....	6451.4	....	122.9	768.1	2284.9	262.6	3156.2	286.9	434.0
Sucrene Digested	......	....	18778.6	850.9	543.0	3294.5	1202.4	1972.7	11432.2	3152.4	3606.5
Per Cent. Digested	......	....	70.96	40.77	66.79	66.79	41.56	95.59	79.06	96.76	95.70
Steer No. 2											
Hay Fed	xxx	10000 0	8876.0	431.0	127.0	794.0	2974.0	457.0	4220.0	182.0	251.00
Hay Refused	974	130.0	116.9	5.4	.9	5.8	43.4	7.1	55.2	2.7	4.70
Hay Eaten	......	9870.0	8759.1	425.6	126.1	788.2	2930.6	449.9	4164.8	179.3	246.3
Sucrene Eaten	844	30000 0	26304.0	1944.0	795.0	4974.0	3039 0	1260.0	15087.0	3258.0	3768.0
Total Eaten	......	39870.0	35063.1	2369.6	921.1	5762.2	5969.6	1709.9	19251.8	3437.3	4014.3
Total Excreted	865	61340.0	13752.0	1601.0	343.5	2146.8	3134.0	521.4	6348.8	153.9	168.7
Digested	......	....	21311.1	768.6	577.6	3615.4	2835.6	1188.5	12903.0	3283.4	3845.6
Hay Digested	......	....	3901.3	33.5	58.0	362.5	1485.8	122.4	1841.3	122.2	183.7
Sucrene Digested	......	....	17409.8	735.1	519.6	3252.9	1349.8	1066.1	11061.7	3161.2	3661.9
Per Cent. Digested	......	....	66.19	37.82	65.28	65.28	44.42	84.62	73.34	96.89	97.15

TABLE XIX—CONTINUED.

Showing Digestibility of Sucrene. Period II—Length of Preliminary Period 9 days, and Digestion Period 5 days.

(Weight in grams—453.6 grams=1 pound.)

	Anal. No.	Fresh Substance	Dry Substance	Ash	Nitrogen	Crude Protein	Crude Fiber	Ether Extract	N-Free Extract	Sugars before Inv.	Sugars after Inv.
Steer No. 3											
Hay Fed	xxx	23000.0	20414.0	991.0	292.1	1825.6	6840.0	1051.0	9706.4	418.6	577.3
Hay Refused	975	150.0	132.4	6.5	1.6	10.0	53.0	4.2	58.7	1.9	3.4
Hay Eaten	......	22850.0	20281.6	984.5	290.5	1835.6	6787.0	1046.8	9647.7	415.7	573.9
Sucrene Eaten	844	30000.0	26304.0	1944.0	795.0	4974.0	3039.0	1260.0	15087.0	3258.0	3768.0
Total Eaten	......	52850.0	46585.6	2928.5	1035.5	6809.6	9826.0	2306.8	24734.7	3673.7	4341.9
Total Excreted	867	86080.0	17240.0	1997.0	387.3	2420.6	4424.0	602.5	7795.9	93.0	122.2
Digested	......	....	29345.6	931.5	698.2	4389.0	5402.0	1704.3	16938.8	3580.7	4219.7
Hay Digested	......	....	10412.6	179.9	153.2	957.5	3871.3	344.7	4925.2	352.2	505.1
Sucrene Digested	......	....	18933.0	751.6	545.0	3431.5	1530.7	1359.6	12013.6	3228.5	3714.6
Per Cent. Digested	......	....	71.98	38.67	68.56	68.56	50.36	107.9	79.64	99.10	98.56
Steer No. 4											
Hay Eaten	xxx	26000.0	23075.0	1120.5	330.2	2064.2	7732.0	1188.0	10970.3	473.2	652.6
Sucrene Eaten	844	30000.0	26304.0	1944.0	795.0	4974.0	3039.0	1260.0	15087.0	3250.0	3768.0
Total Eaten	.....	56000.0	49379.0	3064.5	1125.2	7038.2	10771.0	2448.0	26057.3	3731.2	4420.6
Excreted	868	107210.0	21300.0	2015.6	450.3	2819.6	6260.8	696.8	9507.2	115.8	116.9
Digested	......	....	28079.0	1048.9	674.9	4218.6	4510.2	1751.2	16550.1	3615.4	4303.7
Hay Digested	......	....	12686.6	286.7	198.0	1237.5	4529.4	467.6	6065.5	394.6	563.5
Sucrene Digested	......	....	15392.4	762.2	476.9	2981.1	....	1283.6	10484.6	3220.8	3740.2
Per Cent. Digested	......	....	58.51	39.21	59.99	59.99	....	101.85	69.51	99.08	99.26
Average for 4 steers	......	....	66.91	39.12	65.15	65.15	34.08	97.49	75.39	97.96	97.67

IV. THE DIGESTIBILITY OF MUELLER'S MOLASSES GRAINS.

Mueller's Molasses Grains is represented to be a mixture of molasses, distillers' and brewers' grains. It appears to be simply the molasses absorbed by the grain and as far as any claims set forth in the advertising matter this would seem to be the process employed in its manufacture. Mueller's Molasses Grains represents a different class of molasses feeds from the Sucrene. It is rather high in moisture and inclined to cake. The amount of moisture which it contains may cause it to ferment. It does not break very readily and thus is not as easy to handle in feeding as is desirable.

The details of the amount of food consumed and the data from which the digestion coefficients were determined are given in tables 20 and 21.

The feed used in these experiments was purchased from the Washington, D. C., dealer. The steers when fed for some time on this feed showed signs of bloating and refused to eat it. There seemed to be an excessive amount of gas formed which probably was produced by an acid fermentation in the stomach. This condition occurred with three out of the four steers under test.

TABLE XX.

Showing Consumption of Hay, Mueller's Molasses Grains and Water. Digestion Period V.

(Food eaten and water drunk.)

Portion of Period	No. Days	Hay Eaten		Grain Eaten		Water Drunk	
		Total	Average Per Day	Total	Average Per Day	Total	Average Per Day
Steer No. 1							
Preliminary	9	35610	3957	35100	3900	301810	33534
Digestion	5	19800	3960	30000	6000	194840	38968
Steer No. 2							
Preliminary	9	35620	3958	33340	3704	264460	29384
Digestion	5	19590	3918	30000	6000	167560	33512
Steer No. 3							
Preliminary	9	31480	3497	43500	4833	298000	33111
Digestion	5	19840	3968	30000	6000	186650	37330
Steer No. 4							
Preliminary	9	35920	3991	43500	4833	307220	34135
Digestion	5	20000	4000	20000	6000	189560	37912

TABLE XXI.

Showing the Digestibility of Mueller's Molasses Grains. Digestion Period V—Length of Preliminary Period 9 days, Digestion Period 5 days.

(Weight in grams — 453.6 grams = 1 pound.)

	Anal. No.	Fresh Substance	Dry Substance	Ash	Nitrogen	Crude Protein	Crude Fiber	Ether Extract	N-Free Extract	Sugars before Inv.	Sugars after Inv.
Steer No. 1											
Hay Fed	xxx	20000.0	17752.0	862.0	254.0	1587.5	5948.0	914.0	8440.5	364.0	502.0
Hay Refused	973	200.0	176.7	9.3	1.8	11.2	67.8	4.4	82.8	2.9	5.9
Hay Eaten	......	19800.0	17575.3	852.7	242.2	1576.3	5880.2	909.6	8356.7	361.1	496.1
Grain Eaten	000	30000.0	23499.0	1536.0	888.0	5540.0	2451.0	846.0	13126.0	5784.0	6534.0
Total Eaten	......	49800.0	41074.3	2388.7	1130.2	7116.3	8331.2	1758.6	21482.7	6145.1	7030.1
Total Excreted	955	98360.0	14154.4	1455.8	383.6	2397.5	3924.5	491.8	5884.4	130.8	69.8
Total Digested	......	....	26920.3	932.9	746.6	4718.8	4406.7	1263.8	15598.3	6014.3	6960.3
Hay Digested	......	....	6425.5	....	117.7	735.6	2274.5	262.1	3143.8	285.9	431.8
Grain Digested	......	....	20494.8	932.9	628.9	3983.2	2132.2	1001.7	12454.5	5728.4	6528.5
Per Cent. Digested	......	....	87.22	60.74	70.82	70.82	86.99	118.40	94.89	99.0	99.9
Steer No. 2											
Hay Fed	xxx	20000.0	17752.0	862.0	254.0	1587.5	5948.0	914.0	8440.5	364.0	502.0
Hay Refused	974	410.0	368.7	16.9	3.0	18.7	136.9	22.3	173.9	8.6	14.7
Hay Eaten	......	19590.0	17383.3	845.1	251.0	1568.8	5811.1	891.7	8266.6	355.4	487.3
Grain Eaten	000	30000.0	23499.0	1536.0	888.0	5540.0	2451.0	846.0	13126.0	5784.0	6534.0
Total Eaten	......	49590.0	40882.3	2381.1	1139.0	7108.8	8262.1	1737.7	21392.6	6139.4	7021.3
Total Excreted	956	86800.0	19505.0	1947.0	553.0	3456.0	5518.0	554.2	7929.8	54.7	64.2
Total Digested	......	....	21377.3	434.1	586.0	3652.8	2744.1	1183.5	13462.8	6084.7	6957.1
Hay Digested	......	....	7742.5	6666	115.5	711.9	2946.2	242.6	3654.7	242.2	363.3
Grain Digested	......	....	13634.8	434.1	470.5	2930.9	....	830.9	9808.1	5842.5	6593.8
Per Cent. Digested	......	....	58.02	28.26	52.92	52.92	....	98.22	74.72	101.0	102.5

Steer No. 3											
Hay Fed	xxx	20000.0	17752.0	862.0	254.0	1587.5	5948.0	914.0	8440.5	364.0	502.0
Hay Refused	975	160.0	141.2	7.0	1.7	10.6	56.5	4.5	62.6	2.0	3.6
Hay Eaten	......	19840.0	17610.8	855.0	252.3	1576.9	5891.5	908.5	8377.9	362.0	498.4
Grain Eaten	000	30000.0	23499.0	1536.0	888.0	5540.0	2451.0	846.0	13126.0	5784.0	6534.0
Total Eaten	......	49840.0	41109.8	2391.0	1140.3	7116.9	8342.5	1754.5	21503.9	6146.0	7032.4
Total Excreted	957	84710.0	19208.0	1888.8	566.6	3541.3	6162.2	649.3	6966.4	110.1	84.7
Total Digested	......	....	21801.8	502.2	573.7	3575.6	2180.3	1105.2	14537.5	6035.9	6947.7
Hay Digested	......	....	9041.4	156.2	133.0	831.3	3106.0	299.2	5068.6	306.8	438.6
Grain Digested	......	....	12760.4	346.0	440.7	2744.3	....	806.0	9468.9	5729.1	6509.1
Per Cent. Digested	......	....	54.30	22.53	49.63	49.63	none	95.28	72.14	99.0	99.6
Steer No. 4											
Hay Eaten	xxx	20000.0	17752.0	862.0	254.0	1587.5	5948.0	914.0	8440.0	364.0	502.0
Grain Eaten	000	30000.0	23499.0	1536.0	888.0	5540.0	2451.0	846.0	13126.0	5784.0	6534.0
Total Eaten	......	50000.0	41251.0	2398.0	1142.0	7127.5	8399.0	1760.0	21566.0	6148.0	7036.0
Total Excreted	958	89840.0	17653.0	1725.2	523.2	3270.0	5398.0	656.8	6612.0	97.9	89.6
Total Digested	......	....	23598.0	672.8	495.4	3086.2	3001.0	1103.2	14954.4	6050.1	6946.4
Hay Digested	......	....	6490.1	....	123.4	771.3	2300.7	263.4	3175.1	303.7	433.4
Grain Digested	......	....	17107.9	672.8	495.4	3086.2	700.3	839.8	11978.9	5746.4	6513.0
Per Cent. Digested	......	....	72.82	43.81	55.79	55.79	28.56	99.27	91.26	99.3	99.7
Average for 4 steers	......	....	68.09	38.84	57.29	57.29	28.89	102.79	83.25	99.8	100.4

SUMMARY OF RESULTS.

In order that the results may be studied with greater ease and a comparison of the rations made, the averages of the results obtained are brought together in table No. 22.

TABLE XXII.

Showing average coefficients of Digestibility obtained in the Experiments together with those of Wheat Bran for comparison.

(Average of results obtained with 4 steers.)

	Dry Substance	Ash	Crude Protein	Crude Fiber	N-Free Extract	Fat	Sugars before Inv.	Sugars after Inv.
	%	%	%	%	%	%	%	%
1. Hay (Average of 4 steers)......	48.4	17.2	44.3	51.3	47.0	32.1	78.9	84.0
2. Hay (Average of 2 steers)...........	40.6	3.9	47.3	44.7	40.9	28.0	73.7	80.8
3. Hay and Molasses (Aver. of 2 steers)	57.6	14.1	38.3	52.9	63.7	27.0	94.6	97.7
4. Mixed Grain.......	64.9	18.1	67.1	16.8	72.1	93.3	107.1	103.6
5. Mixed Grain and Molasses.........	78.9	49.4	71.5	40.2	88.6	102.0	98.9	99.9
6. Sucrene...........	66.9	39.1	65.2	34.1	75.4	97.5	97.9	97.7
7. Mueller's Molasses Grains...........	68.1	38.8	57.3	28.9	83.2	102.8	99.8	100.4
Wheat Bran......	67.3	47.1	82.3	25.1	74.6	54.7	....	....

These results show that the addition of molasses to a ration has a tendency to increase the digestibility of both hay and grain feeds. This coupled with the generally observed fact that molasses contributes toward making feeds more palatable and also acts as an appetizer gives to molasses a relatively high place as a stock food and makes it more valuable than its analysis alone would indicate.

The results obtined with Sucrene and Mueller's Molasses Grains when compared with those obtained for the mixed grain ration used, show quite evidently that the molasses which they contain have contributed toward making them more digestible and giving them a higher feeding value than they would have had without the molasses. The mixed grain ration used contained a greater variety of grains than is used by most dairymen and probably average well with any in quality, yet both the Sucrene and Mueller's Molasses Grains showed a higher digestibility.

In studying these figures the point is noticed that the protein is sometimes not so digestible in the presence of molasses, and this suggests the thought that it may be that the presence of the readily available energy of the molasses has filled the requirements of the animal and thus not necessitated the breaking up of more difficult protein compounds.

EFFECTS OF MOLASSES ON NITROGEN METABOLISM.

It is sometimes claimed that the excess of salts contained in molasses, and like foods, stimulate an extra secretion of urine and thus may bring about consumption and waste of nitrogenous compounds from the system. With an idea of seeing if there was any special indications in this direction, during the periods when the digestibility of the feeds were being determined, the urine was collected and the total nitrogen determined in it. The results obtained are set forth in tables 23 and 24, from a study of which it would seem that there may have been a slight increase in the quantity of urine secreted during the periods when molasses was being fed, but that the percentage of nitrogen usually decreased so as to allow about a constant per cent to be stored in the body. The figures show no special effect which could be attributed to the molasses.

TABLE XXIII.

Showing the quantity and the Nitrogen content of the Urine excreted during five days of Digestion Period.

Period	STEER No. 1		STEER No. 2		STEER No. 3		STEER No. 4	
	Quantity grams	Nitrogen %	Quantity grams	Nitrogen %	Quantity grams	Nitrogen %	Quantity grams	Nitrogen %
I.........	16850*	0.70	8800*	1.23	13390*	0.61	10140*	0.59
II........	31950*	1.29	17900*	1.61	34580*	0.95	39760*	0.85
III.......	42890*	1.29	32850	1.49	17600*	1.89	19950*	1.86
IV.......	41830*	1.44	28730*	1.19	33620*	1.50	28710*	1.53
V........	55400	1.35	55380	1.30	49810	1.10	53470	1.14
VI.......	23700	0.87	19370	0.99	....	....	....	....

*Some urine lost.

TABLE XXIV.

Showing the Nitrogen Metabolism during the different Digestion Periods.

Period	Steer No.	N-in Urine Grams	N-in Dung Grams	Total Excreted	Total Eaten	Total Stored	% Stored	% of Excreted N-in Urine
I Hay	1	106.58	157.5	264.1	306.4	42.3	13.78	40.37
	2	85.97	126.5	212.5	233.8	21.3	9.11	40.46
	3	74.20	175.7	249.9	371.6	121.7	32.75	29.69
	4	55.11	147.8	202.9	369.1	166.2	45.03	27.16
Average......	....	80.46	151.9	232.4	320.3	87.9	25.17	34.42
II Sucrene	1	352.27	400.0	752.3	1047.9	295.6	28.21	46.83
	2	283.44	343.5	726.9	921.1	194.2	21.08	38.99
	3	339.50	387.3	726.8	1085.5	358.7	33.04	46.71
	4	338.06	450.3	788.4	1125.2	336.8	29.93	42.89
Average......	....	328.32	395.3	748.6	1044.9	296.3	28.07	43.86
III Mixed Grain	1	550.56	532.7	1083.3	1243.2	159.9	12.86	50.82
	2	490.28	392.9	883.2	1230.5	347.3	28.22	55.52
	3	832.59	394.5	727.1	1231.0	503.9	40.94	45.75
	4	378.28	361.5	739.8	1243.0	503.2	40.48	51.14
Average......	....	437.93	420.4	858.4	1236.9	378.6	30.63	50.81
IV Mixed Grain and Molasses	1	595.58	406.5	1002.1	1325.6	323.5	24.41	59.43
	2	341.8	432.8	774.6	1327.5	552.9	43.12	42.69
	3	578.24	462.0	1040.2	1271.1	230.9	18.17	55.59
	4	432.69	383.0	815.7	1327.8	512.1	38.57	53.04
Average......	....	409.69	421.1	903.3	1313.0	409.7	31.07	52.69
V Mueller's Molasses Grains	1	745.16	383.6	1128.8	1130.2	1.4	.12	66.01
	2	715.09	553.0	1268.1	1139.0	none	none	56.38
	3	551.11	566.6	1117.7	1140.3	22.6	.20	49.31
	4	483.39	523.2	1006.6	1142.0	135.4	11.86	48.02
Average......	....	623.69	506.6	1130.3	1137.9	39.9	3.05	54.93
VI. Hay and Molasses	1	200.62	187.6	388.2	322.5	none	none	51.68
	2	186.79	207.0	393.8	318.8	none	none	47.43
Average......	....	193.71	197.3	391.0	320.7	none	none	49.56

THE MARYLAND
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ALFALFA IN MARYLAND.

By C. W. Nash.

HISTORY OF ALFALFA.

Alfalfa has been used as a forage crop in Egypt, Greece and other Eastern countries for over 2,000 years. It is a native of Eastern Asia, where it thrives particularly well on the high dry plateaus. It was brought to Mexico by the Spaniards about four hundred years ago, and from there was taken to South America. It was introduced into the United States over a century ago from Central Europe, under the name of Lucerne, but was only locally grown until after its introduction into California from Chili, in 1854. From California it gradually worked its way Eastward, until now it is the chief forage crop in many of the Western States, and is being grown to some extent in nearly every State and Territory in the Union. No other forage crop is exciting so much attention at the present time.

ALFALFA IN MARYLAND.

Alfalfa was tried in Maryland over fifty years ago, and there are farmers who have been growing it for twenty to forty years, but its distribution has been only local until a few years ago, when the Maryland Agricultural Experiment Station, in cooperation with the United States Department of Agriculture, furnished seed to a large number of farmers to encourage them to try it experimentally. and to get data as to its adaptability to Maryland conditions. In the spring of 1902 question sheets were sent to each of these farmers for information as to the methods they had used in preparing the seed bed and seeding, and as to their success in growing alfalfa. The fall following a bulletin on "Alfalfa in Maryland" was issued by the Experiment Station.

Since 1902 several cooperative tests with farmers have been started, and many other farmers have tried alfalfa. Another list of questions was sent out in 1906, the object being to obtain information as to what character of soil and what methods of culture have given the best results in this State. While it was not possible to send a circular letter to every farmer growing alfalfa, and some of those to whom it was sent did not reply, the number of responses made was sufficient to fairly represent the average conditions in the State. There were two hundred ninety-two letters sent out, from which one hundred fifty-eight replies were received, thirty-six reporting failure, and one hundred twenty-two reporting the alfalfa doing well. The total acreage reported by these letters was about eight hundred acres. These one hundred twenty-two successful growers are located in every county of the State, except Wicomico and Caroline counties, and each of these two counties have in at least one instance in the past grown alfalfa successfully. The fact that the three counties having the largest acreage, namely, Baltimore, Talbot and Allegany, are in different sections of the State also shows that alfalfa is of general rather than sectional distribution.

The season of 1906 was exceptionally unfavorable for alfalfa. The drought in the early summer doubtless lessened the vitality of the plants, and the excessively long wet period in late summer practically kept, even those soils which were normally well drained, in a saturated condition. The effect was much more noticeable on the 1905 seedings than on the older fields, showing that alfalfa is not as hardy the first year as it is when older.

During the spring of 1907 a circular letter was sent to each of the one hundred twenty-two parties who had previously reported success with alfalfa, asking a reply as to the yield and number of crops obtained in 1906. The following table gives the dates of seeding, the yields per acre, and other data reported by alfalfa growers:

Names	County	Date Sown	No. of Acres	Yield per Acre	No. of Cuttings
				Tons	
John W. Llewellyn	Allegany	Apr. 1900	10	4½	3
M. R. Wilson	"	6 yrs. ago	7	2¼	3
M. R. Wilson	"	3 yrs. ago	5	3½	4
W. A. Combs	A. A. Co.	....	14	*	4
L. A. Palmer	" " "	....	5	2¼*	3
Harry Alder..................	Baltimore	Apr. 1900	2	5	......
Chas. A. Councilman.........	"	12 yrs. ago	66	5	4
T. V. Richardson	"	Apr. 1903	2	3½	3
Ephraim Haines..............	Carroll	Aug. 1904	1	7	4
Wm. Coulby..................	Charles	....	5	2½	2
E. W. Dawson.	Cecil	6 yrs. ago	⅝	*	......
T. J. Hackett................	Dorchester	....	4	4½	3
R. R. Lewis..................	Frederick	....	18	3½	3
John Schafer	"	May 1903	1	*	4
H. P. Weber..................	Garrett	May 1902	1	3	2
Dr. Herbert Hoopes..........	Harford	....	4	3	3
Wm. Mikel....................	"	....	6½	3½	3
Earnest N. Adams............	Howard	....	18	3	3
Abram S. Crawford..........	Kent	....	2	4½	4
Samuel L. Wright............	"	June 1902	2½	*	......
C. C. Mainhart	Montgomery	Aug. 1905	3	3	3
Dr. A. Stabler................	"	....	6	3	3
E. P. Thomas	"	Aug. 1905	3	3½	3
John Dicus....................	Prince George	Aug. 1905	1	3	2
Jas. T. Anthony..............	Queen Anne	....	4	3¼	4
D. E. C. W. Thom............	" "	....	3	3¾	4
C. B. Greenwell..............	Saint Mary's	....	3	3½	4
A. Hyatt.....................	" "	May 1903	1	5	5
A. Hyatt.....................	" "	Aug. 1905	2	6	6
Jos. M. Mattingly............	" "	Apr. 1904	4½	4½*	4
Wm. S. Richardson	Somerset	....	8	6½	4
A. Sudler	"	....	1½	4	4
John Aikenhead..............	Talbot	....	1	5½	3
Miss Julia Dixon	"	Aug. 1905	1	6	5
Chas. E. Fairbanks	"	....	8	4	3
Geo. B. Taylor...............	"	....	4	4¼	4
Jno. S. Rohrer	Washington	....	1	4½	3
I. T. Costen..................	Worcester	....	1	3¼	4
F. E. Matthews	"	....	1	5*	......

The above yield reported by Mr. Ephraim Haines, Medford, Maryland, shows what may be accomplished under favorable conditions, his four cuttings in 1906 making a total measurement of twelve feet, and a total yield which was estimated at seven tons per acre.

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*Mr. W. A. Combs reports four good cuttings a year.

*Mr. L. A. Palmer, three tons per acre in 1905, and two and one-fourth tons in 1906.

*Mr. E. W. Dawson, five or six tons per acre for six years.

*Mr. John Schafer, five tons per acre in 1905.

*Mr. Samuel L. Wright, five tons per acre in 1903-04-05.

*Mr. Joseph M. Mattingly, five and one-third tons per acre in 1905, and four and one-half tons in 1906.

*Mr. F. E. Matthews, five tons per acre in 1906, and five to seven tons per acre each year previous.

Rev. P. P. Arnd, Elkton, Maryland, reports that his first cutting in 1905 attained a height of five feet, and yielded one ton of hay from one-eighth acre of land, and produced sufficient hay and green forage during the season to keep a cow in a very heavy flow of milk from May to December, seven months, with no other feed except three hundred to four hundred pounds of ground grain, mostly bran and corn. Estimating the amount of hay required to keep a cow seven months at two tons, a yield of hay at the rate of sixteen tons per acre was obtained.

Some of the experiences of Maryland farmers show that alfalfa may remain a profitable crop for several years without reseeding. Mr. J. T. Davis, Federalsburg, Maryland, had a field of one-half acre, sown in 1895, which made an average of about four cuttings a year until 1905, when it was plowed up. Mr. John Llewellyn, Cumberland, Maryland, has a field of ten acres, sown in 1900, which seems to be getting better every year, and last year made a yield of four and one-half tons per acre. Hon. Charles A. Councilman has a field of sixty-six acres, sown twelve years ago, which made four or five tons per acre last year. Other fields mentioned in the preceding table also show the longevity of alfalfa in this State.

SOILS FOR ALFALFA.

Alfalfa may be successfully grown on a great variety of soils, but is much more easily grown on certain types of soil than others. The best soil is one with a surface sufficiently heavy to retain an abundance of moisture, and furnish a good storehouse for plant food, and with a fairly deep sub-soil sufficiently porous to allow good under-drainage. The soil survey types of Maryland possessing these characteristics in the largest degree are the Sassafras loam, the Sassafras sandy loam, the Cecil loam and the Cecil mica loam.

The Sassafras loam occurs in large areas on the Eastern Shore of Maryland, and in small, much-scattered areas on the Western Shore, and in Southern Maryland. It is a brown loam to a depth of eight to ten inches, underlaid by a yellow clay to a depth of three to thirty feet, below which is a layer of sand or gravel a foot or more in thickness, which gives good under-drainage if it lies sufficiently near the surface. The Sassafras sandy loam closely resembles the Sassafras loam, except that it contains more sand, and is a lighter and better drained soil.

The Cecil loam and the Cecil mica loam occur in large areas in the Piedmont Plateau. They are made of disintegrated rock, and are sufficiently loose to allow good drainage, yet, sufficiently compact to retain a fair amount of moisture and hold plant food in store. They are brown-colored loams at the surface, beneath which is a deep layer of slightly lighter colored loam. The Cecil mica loam, as its

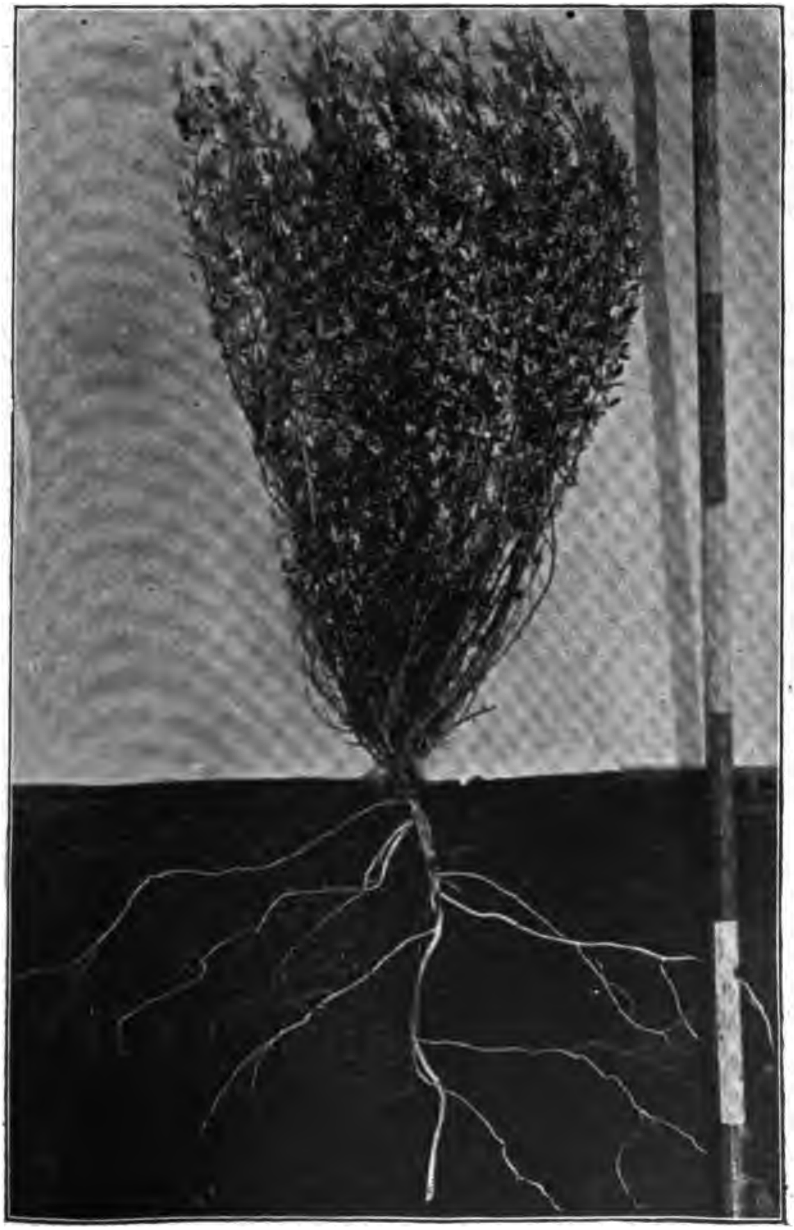

Plate I—A Vigorous Two-Year Old Alfalfa Plant.

name implies, contains a larger amount of mica. It is not so abundant as the Cecil loam.

Limestone soils are usually well suited to the growing of alfalfa. These are clay soils, underlaid with limestone rock at varying depths, and occur in considerable areas in Baltimore, Carroll, Frederick and Washington Counties. This portion of the State has a much higher elevation, and a much lighter rainfall, than Eastern and Southern Maryland, and appears to be in every way suited to the production of alfalfa. Two precautions, however, should be taken in choosing a field for alfalfa on the limestone soils; the rock must lie several feet (preferably four or more) below the surface, to give ample room for the deep-growing alfalfa roots to develop, and the soil must be well drained, preferably well drained at the surface by the slope of the land, and well under-drained through layers of sand or gravel, or other porous strata.

The general classes of soils which have the best physical condition naturally are the sandy, medium and clay loams. The loamy sands and the medium heavy clays, however, may be made suitable for alfalfa growing by manuring and drainage. The light sandy and the very heavy clay soils are least adapted to growing alfalfa. On sandy soils well stocked with humus the growth has been vigorous when moisture has been abundant, but during droughts the alfalfa has suffered severely, and during the winter it has been thrown out by the heaving or the alternate freezing and thawing of the soil. On some sandy soils sown in the fall of 1906 the crop was entirely destroyed by the plants being heaved out. On heavy clay soils in good tilth alfalfa has thrived well under moderate rainfall, but during the excessive wet periods it has been "drowned out," and during the winter it has been thrown out by heaving. The soils least affected by heaving are those composed of soil particles of moderate size, and containing a large amount of humus. The danger from heaving is much greater the first winter after seeding than later, after the plants have become deeply rooted.

Alfalfa does best on well-drained soils where the water level is several feet below the surface. Alfalfa is a very deep-rooted plant, sending its roots down into sub-soil which is largely unavailable to other farm crops. These roots will not thrive in a water-soaked soil, and in attempting to grow alfalfa on a wet soil, or a soil with the water level only a few feet from the surface, the alfalfa is placed in unnatural conditions, and little can be expected of it. If possible, a field with a sufficient slope to effect thorough surface drainage, and sufficiently open or porous to provide good under-drainage, should be selected for alfalfa. Strata of sand or gravel a few feet below the surface usually make a very effective drain. Soils which are not well drained may often be made suitable for alfalfa growing by the use of open ditches or by tile drainage.

ALFALFA IN ROTATION OF CROPS.

The best crops to precede alfalfa are those that leave the land unusually free from weeds and weed seeds, and those that add organic matter, and thus enrich the soil. Corn and potatoes are good for the first purpose, and crimson clover and cow-peas for the second. On land rich in organic matter the cow-peas or crimson clover may be cut for hay, but on lands very deficient in humus, it may be more profitable to plow under the whole growth. Potatoes are very good for getting the land in condition, and several farmers in this State have been the most successful when they have sown alfalfa after early potatoes. Land that is used for trucking, if not too light, usually does well, because such land has been prepared by manuring and cultivation. Alfalfa should not follow directly after a sod, as grasses usually run the alfalfa out within two or three years. A crop of corn grown between a sod and alfalfa will give time for the sod to decompose, and will destroy most of the grass. Where sweet corn is grown for canning purposes, and the crop removed as early as possible, it may be followed by alfalfa, and when the land is rich in vegetable matter alfalfa may be sown in the fall, after wheat, if special preparation of the land is made. In preparing for alfalfa the rotation should be planned ahead for two or more years, as mentioned below under "Soil Enrichment."

SOIL ENRICHMENT.

One of the principal causes of failure of alfalfa in Maryland has been a lack of sufficient organic matter in the soil. The continuous cropping with tobacco, or one or two of the grain crops, has more or less exhausted the humus or organic matter, and has thus affected its supply of plant food, its physical condition, and its capacity for holding moisture. It is necessary on these humus-exhausted soils, if one would have success with alfalfa, to replace the plant food removed by continuous cropping, by the application of barnyard manure, by the use of green manure crops, or by the rotation of crops in which legumes, such as cow-peas, vetch and clover are used. The quickest way to increase the organic content of the soil, and improve its physical condition, when plenty of manure is not available, is by use of green manure crops. The legumes best adapted to this purpose are cow-peas, vetch and crimson clover. Other crops which may be used for green manuring are wheat, rye and sorghum. These crops may be grown one after the other, or grown in rotation with other crops, as shown in rotation plans in the following paragraph.

A good rotation, when a few years can be allowed to fit a field for alfalfa, is as follows:

First year—Corn, followed by crimson clover.

Second year—Crimson clover, followed by cow-peas, and seeded to wheat in fall.

Third year—Wheat, followed by cow-peas or vetch.
Fourth year—Corn, followed by crimson clover.
Fifth year—Crimson clover, followed by alfalfa.

The crimson clover may be sown in the corn field after the last cultivation, and should be ready to cut in May of the following season, in time to grow a crop of New Era cow-peas, which should be cut early enough to allow the seeding of wheat in the fall. By this rotation, even by using the cow-peas for hay, the land will continually become richer, and at the same time will usually be bringing in better returns than it would by continuous grain farming. If both the cow-peas and crimson clover are turned under, the land should become rich enough in organic matter at the end of the rotation, even without manure to produce good crops of alfalfa. This system is one that may be used to advantage when manure is not available, and when large fields are being fitted for alfalfa seeding. When manure is plentiful, the following preparation will be sufficient: Corn followed by crimson clover the first year, with the crimson clover plowed under the next spring, and the ground summer fallowed, and alfalfa sown in the fall, or crimson clover cut for hay and a heavy coat of manure plowed under in its place. When plowing for the corn a heavy coat of manure should be turned under. Land that is in wheat may be fitted for alfalfa quickly by sowing cow-peas after the wheat, and by plowing them under in late fall, or by sowing crimson clover, and plowing it under the next spring, then seeding cow-peas which may be cut for hay, manure preferably having been plowed under for both the fall and spring crops. The manure should be applied to the crops preceding the alfalfa, so that there will be sufficient time to improve the physical condition of the soil, and to kill the weeds introduced by the manure; however, if the manure is well rotted, so that it is free from weed seed an application of manure is beneficial even at seeding time.

The value of manure in growing alfalfa has been well demonstrated on the farm of Mr. Henry Fuss, of Union Bridge, Carroll County, who seeded two acres of alfalfa in the fall of 1905. A load or two of well-rotted manure from the hog lot was spread on one corner of the field before sowing the alfalfa, and in the spring of 1907 there was a perfect stand of rank-growing alfalfa where the manure was applied, while around it the alfalfa had been mostly killed, and was much smaller.

The value of manure is shown on other farms. There are several growers in the State who have two or more fields of alfalfa, one field having been manured, and having plenty of humus and nitrogen, and others which have not been manured, and have been continuously cropped without a legume in the rotation, who have a permanent stand on the manured field, while the unmanured fields have never produced much, and at the end of a year or two were practically worthless. Farmers who are using large amounts of barnyard and green manures are raising large crops of alfalfa, while others in the same locality, and under similar soil conditions, but who are not using anything but commercial fertilizers are unable to grow alfalfa with any success. One illustration of such a condition may be found in Baltimore County, around Glyndon, where Mr. Councilman has been growing alfalfa successfully for years, and has a sixty-six acre field that is twelve years old, and yet so far as known to the writer, or Mr. Councilman, no one else has grown the crop successfully within several miles of Mr. Councilman's farm, although many have tried raising it.

Commercial fertilizers are of value in that they supply available plant food, but they will not take the place of manure because they do not add vegetable matter to form humus, and to improve the physical condition of the soil. Their chief value is in conjunction with manure to furnish the mineral elements, phosphorous and potassium, and to furnish a greater abundance of plant food for the alfalfa while young and tender. It can doubtless be used with profit at time of seeding for these reasons.

LIMING.

Alfalfa reaches its highest development on neutral or slightly alkaline soils. In acid soils it usually has a sickly, yellow appearance, and does not make a vigorous growth, doubtless due to the fact that the acid conditions are not suited to the development of the alfalfa bacteria.

The acidity or alkalinity of the soil may be tested by the use of blue litmus paper, which can be secured of any druggist. The litmus test may be made by moistening a portion of the soil so that it will stick together, and inserting the litmus paper in a cut made with a knife, and closing the soil together compactly around the paper. If within a half hour or less the litmus paper turns pink the need of lime is indicated. Where tests are not made, and the soil has not been limed for years, it is much safer to lime than to run the risk of the alfalfa being killed out by the acidity of the soil. The amount that should be applied varies with different soils, clay soils requiring a heavier application than sandy soils. On clay soils which have not been limed in many years about one ton per acre should be applied, while soils in which the acidity has been partially corrected should receive a proportionate amount. On sandy or humus exhausted soils it is not advisable to put on more than one thousand pounds at one time, for lime is an indirect fertilizer, and liberates plant food by hastening the decomposition of the organic matter in the soil, and thus reduces its fertility. Clay soils are more retentive of plant food, so that less is lost by this decomposition, and, furthermore, the clay soils are improved greatly in texture by the flocculation of the soil, or the aggregation of the smaller particles into larger ones.

Oyster shell lime or stone lime is generally used, though other substances, such as marl, may be used more economically, where they can be obtained on the farm for the expense of digging. The lime should be applied on the surface, and worked in with the surface soil, and it should be put on in as active a condition as possible. To do this the lime should be slaked with water, and as soon as slaked should be spread as evenly as possible. It may be applied with a shovel, or with the lime attachment which comes with most manure spreaders.

Ground stone lime, which has recently been put on the market, is a finely ground lime, which is easily distributed, and is thought to be better than the burnt lime, as it can be applied in the active state. It can be applied through the fertilizer attachment of the ordinary grain drill.

INOCULATION.

Like other legumes, alfalfa has the ability in the presence of certain microscopic organisms, called bacteria, to obtain nitrogen from the air in the soil. When, however, the bacteria are absent, alfalfa has to depend for its supply upon that already in the soil, and is not able to make a vigorous growth, except when the soil is rich and well supplied with nitrogen, and is not able to build up the nitrogen content of the soil, the great function of leguminous plants.

It is somewhat difficult to determine whether the alfalfa bacteria are present in a field or not before growing alfalfa, but unless the field has previously grown alfalfa, or unless sweet clover has grown on the field, there is little chance of the soil containing the bacteria, and it is advisable to inoculate the soil.

Sometimes a partial inoculation has been secured through bacteria which have been carried upon the seed, but this means of inoculation is uncertain, and not thorough, and should never be depended upon.

Soils may be inoculated artificially in three ways: By inoculated soil; by water extract from inoculated soil, and by the use of artificial cultures of alfalfa bacteria. Inoculation by means of inoculated soil has given much better success than other methods. The soil should be taken from a field known to be well inoculated, and from a place in the field which is as free as possible from harmful weed seeds. The surface soil may be taken to the ordinary depth of plowing, and should be kept in a moist condition, and be kept from the sunlight until it is applied. The soil may be applied with the fertilizer attachment of a grain drill, or if no drill is available, may be sown by hand, and immediately harrowed in. When applied by hand one-half of the soil should be sown one way, and one-half crosswise, in order that no spots may be missed. The inoculated soil should be applied at the rate of four hundred to five hundred pounds per acre, and if plenty of soil may be had conveniently a heavier application may be made. If the inoculated soil must be shipped by boat or rail at great expense, and is known to be well inoculated, it may be applied in smaller quantities, even as low as one hundred fifty to two hundred pounds per acre, with a fair chance of securing inoculation, which, if not perfect at first, will become so within one or two years. In many sections of the State *melilotus alba,* or sweet clover (in some localities called gala gumbar) grows commonly along roadsides and in waste places, and the soil from such spots may

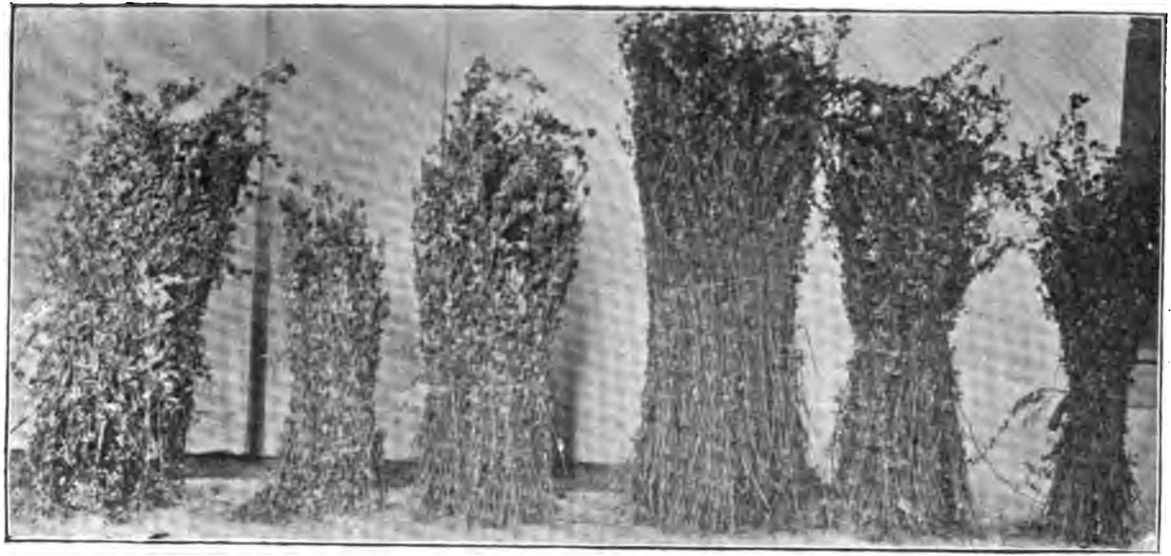

Plate II—Showing Results of Inoculation Experiment.

Plot 1—Inoculated with Alfalfa Soil—Yield 1.50 lbs.
Plot 2—No Inoculation—Yield 0.50 lbs.
Plot 3—Inoculated with Sweet Clover Soil from College Farm—Yield 1.40 lbs.
Plot 4—Inoculated with Sweet Clover Soil from Anne Arundel Co.—Yield 3.15 lbs.
Plot 5—No Inoculation, but Planted in Rows and Cultivated.
Bundle 1—One-half of Plot which showed evidence of Inoculation washed over from Plot 4—Yield 1.05 lbs.
Bundle 2—Other half of Plot 5—Yield .45 lbs.

be used for inoculation, if the alfalfa soil cannot be had near at hand. An experiment conducted by Prof. W. T. L. Taliaferro, formerly Agronomist of the Experiment Station, shows that the sweet clover soil produces as good inoculation as the alfalfa soil (See plate No. II.).

The inoculation by water extract includes the passing of water through an inoculated soil, and using this to inoculate the alfalfa seed, which should be dried out of the sunlight. This method is unsatisfactory in many ways, and is not to be recommended.

The inoculation by means of artificial cultures has usually proved unsuccessful, and until better preparations have been developed and thoroughly tested it is not advisable to use this method.

Every alfalfa grower should know how to determine whether or not his alfalfa is well inoculated. Many farmers in this State who have been growing alfalfa for years say they have never seen a tubercle, though they have looked for them several times. The reason in some cases, doubtless, was because there were no tubercles, but in other cases it evidently was not known what the tubercles were like, or proper methods were not used to find them. Tubercles occur as wart-like growths on the roots, most of them being about the size of a pin head, but sometimes growing in clusters which may be as large as a pea. They are much easier to find on young plants, as they are then nearer the surface, and nearer the main root. They are often noticeable by the time the plants are three or four inches high, and should be very abundant and conspicuous by the time the plants are six or eight inches high. Plate No. III shows some small plants with tubercles on their roots. On older plants the tubercles are more scattered, and are harder to find. However, they can be found by removing a plant with considerable soil attached, and carefully removing the same with the hands, or, better, by means of running water, so as not to break off the small roots where most of the tubercles will be found. When plants a year or more old are pulled up what tubercles they had have usually been left in the soil.

When only a part of the plants have tubercles, by the time the alfalfa is six or eight inches high the inoculation is not what it should be. Fields on which inoculation has been unsuccessful may be inoculated with earth after the first cutting, and the land harrowed with a disc, or spiked-tooth harrow, but inoculation at this time is not so effective as when done at or before seeding time.

PREPARATION OF SEED-BED.

The importance of a good seed-bed cannot be too strongly emphasized, for alfalfa plants are delicate while young, and are very sensitive to unfavorable conditions, such as weeds and lack of moisture. The soil should be fine and loose for the surface two or three inches, and below that should be sufficiently firm to favor capillary action, yet porous enough for good drainage and aeration. On deep, medium or heavy soils the deeper the soil has been plowed the better, and when

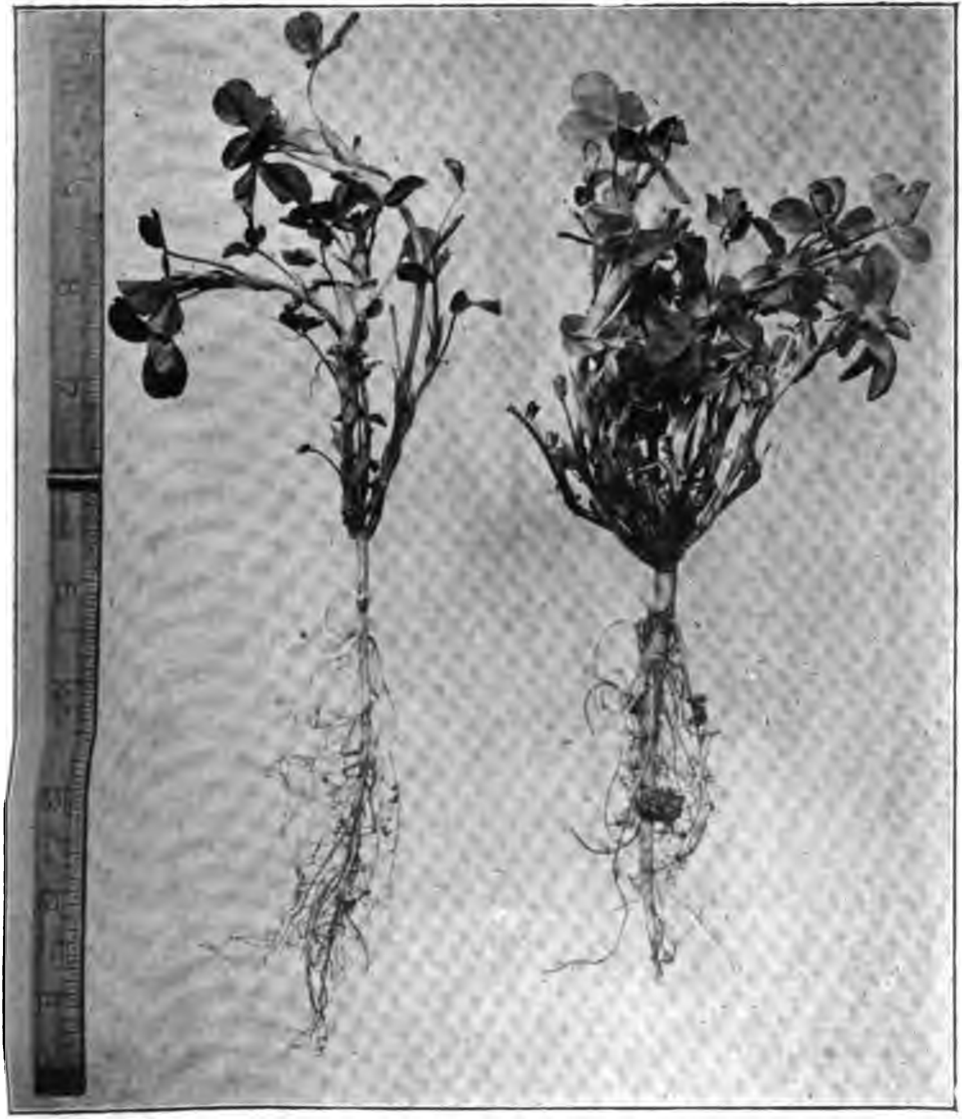

Plate III—Showing Young Alfalfa Plants with Tubercles on Roots.

preparation begins two or three years previous to seeding, the depth of plowing should be gradually increased to eight to ten inches. The proper firmness of the seed-bed is secured when land is plowed from two to six months before seeding time, and only the surface is kept stirred.

The method of preparing the seed-bed will necessarily depend upon the previous cropping and treatment, and upon the length of time which there is to prepare the ground. Sometimes it is not possible to wait long enough for heavy rains to settle the ground without delaying the seeding too long. One of the best ways to prepare the seed-bed is by repeated harrowing with a spiked-tooth harrow, the tramping of the horse's feet, and the weight of the harrow, with teeth set slanting, serving to pack the soil. The value of thus packing the soil was shown in some fields seeded last fall, the edges and corners which were compacted by the horses turning around being much more vigorous and thickly set than the other portions of the field. This was especially noticeable on fields which had no heavy rains to compact

Plate IV—Growth of Alfalfa on inoculated portion of a field sown by Mr. W. Beall, Beltsville, Md., in September, 1905. Picture taken in spring of 1906, when plants were about fifteen inches high.

them, and which had not been plowed very long before seeding. Different ways of preparing the seed-bed after different crops, such as crimson clover, potatoes and wheat, will be considered in the following paragraphs.

A field in crimson clover may be prepared for seeding alfalfa in either of two ways: Plow the crimson clover under as green manure, or cut for hay when in full bloom, and summer fallow until sown to alfalfa; or plow the crimson clover under about May 15, and sow to an early cow-pea, such as the New Era, which should be cut for hay in time to allow two or three weeks to prepare a suitable soil mulch, and to kill most of the weeds before time to seed the alfalfa. When plowing under the crimson clover the plowing should be as deep as possible, so as to loosen up the soil to a greater depth, and then in the fall all that is necessary to do is to get a fine mellow surface of about three inches, free of weeds, the sub-surface being of about the right compactness.

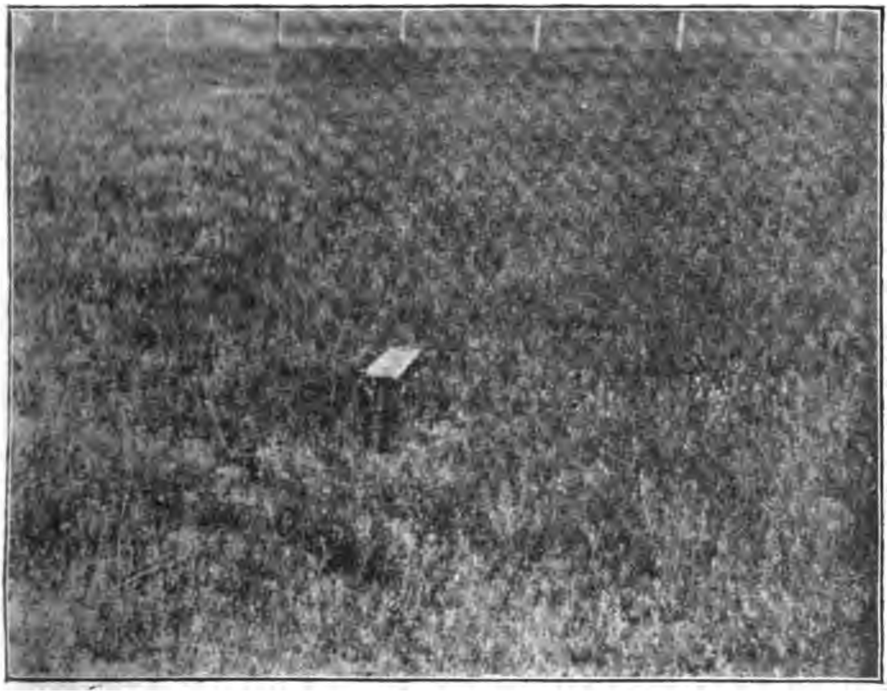

Plate V—Growth of Alfalfa on uninoculated portion of Mr. W. Beall's field. Taken on the same date as Plate IV.

If alfalfa is to follow potatoes, or some other truck crop, and the field is rich, clean and mellow, the potato vines, or other refuse, should be raked off, and the seed-bed prepared by the use of a disc harrow and other surface-working implements. If the field is weedy it should be plowed shallow, or to a depth of about five inches.

Wheat or other small grain when on rich land, previously well cultivated, may be followed by alfalfa if the preparation begins soon enough after harvest. The land after wheat has been removed is usually mellow and somewhat moist, and if the surface is worked up soon will be in good condition but if left for some time will become dry and baked. Early plowing as compared with late plowing will leave the soil more free from clods and will give more time for the compacting of the soil and for the killing of weeds. To kill the weeds and to keep the soil mellow on top so as to conserve the moisture, the harrow should be used every week or after every rain until the field is seeded. If manure is applied at this time it should be a light coat of well rotted manure.

SEEDING ALFALFA.

It is usually conceded that the best time to seed alfalfa is in late summer or early fall. If the field has been summer fallowed it should usually be seeded early in August, but when alfalfa is sown after cowpeas, wheat, or other full season crops, it is usually best to seed in the middle or latter part of August. It should not be seeded until the proper seed-bed has been secured, even if it is necessary to wait until late in August. Seeding after September 1 will not make as vigorous a growth during the fall as the earlier seeding and is more apt to be winter killed. The late summer seeding is preferred to the spring seeding mainly because the alfalfa is able to get well established in the soil during the fall when the weeds are comparatively inactive, and then is able to make a vigorous growth in the spring and keep ahead of the weeds.

Spring seeding may be successful on fertile land which is especially free from weed seeds, and when practiced should be seeded as early as a suitable seed-bed can be prepared. Fall plowed land or land devoted to a cultivated crop the previous season offers the best opportunity of preparing the proper seed-bed. Better results have usually been secured by growing alfalfa without a nurse crop, but some farmers are using this method with good results, especially with spring seeding. A thin seeding of barley is one of the best crops for this purpose. The nurse crop should never be allowed to reach maturity, but should be cut for hay, or, at such frequent intervals that it will not provide dense shade for the alfalfa.

Alfalfa seed should be secured from some reliable firm under guarantee of purity and vitality, and then should be examined for impurities and tested for germination. To give time for this testing the seed should be secured early and in the germination test the seed should test not less than eighty or eighty-five per cent, and better not less than ninety or ninety-five per cent. Every farmer may test the vitality of his own seed. A simple method of testing is to lay in the bottom of a plate two thicknesses of blotting paper or several thicknesses of newspaper, wet thoroughly, and on this place one hundred average seed. These are covered with a layer of wet paper and an inverted plate is put on top of the first plate to prevent drying out from evaporation. The germination should take place in four to six days.

Adulterants are often found in alfalfa seed, some of the most objectionable weed seeds being those of dodder, yellow trefoil and narrow-leaved plantain. If a farmer does not feel confident to judge the grade of alfalfa seed offered him by dealers he may have the purity and viability determined free of cost by the Experiment Station, if he will send a sample of the seed for that purpose. Address: Maryland Agricultural Experiment Station, College Park, Maryland.

Another important thing to consider in buying seed is its source. Variety tests made with European and Asiatic varieties as compared with seed from different parts of the United States show that the foreign seed is less hardy and often less viable than the American-grown seed, and that the seed obtained from the Northern part of the United States is more hardy than that from farther South.

The amount of seed to sow depends upon the quality of the seed and upon the preparation of the seed-bed. If the land is well prepared, and the seed good twelve to fifteen pounds per acre is as satisfactory as a larger amount, for if the seed all grew there would be from sixty-five to eighty plants per square foot, which is many more than will stand after the first season. However, much of the seed on the market is of low vitality and if only about seventy-five per cent. of the seed sown will germinate it should be seeded at not less than twenty pounds per acre. Seed of still lower vitality should be applied at a correspondingly heavier rate.

The seed may be sown with a broadcast seeder, by hand, or may be drilled in, but whatever the method, extreme care should be exercised to distribute the seed evenly and not to cover it too deeply. One objection to using the drill is that the seed is usually put in too deep and comes up poorly. The wheelbarrow grass seeder is one of the best implements for this purpose.

The seed should be covered very lightly, one-half inch to three-fourth inch being sufficient. The best method of covering is by means of the weeder run over once or twice after seeding, or by means of one harrowing with a light spike-tooth harrow with the teeth set shallow. One field sown to alfalfa last fall, under favorable conditions otherwise, but harrowed once each way with the harrow teeth set perpendicular, was covered so deeply that some of the plants were just coming up two months after sowing and the only plants strong enough to survive the winter were those from seed which chanced to be near the surface and were four or five inches high at the beginning of winter.

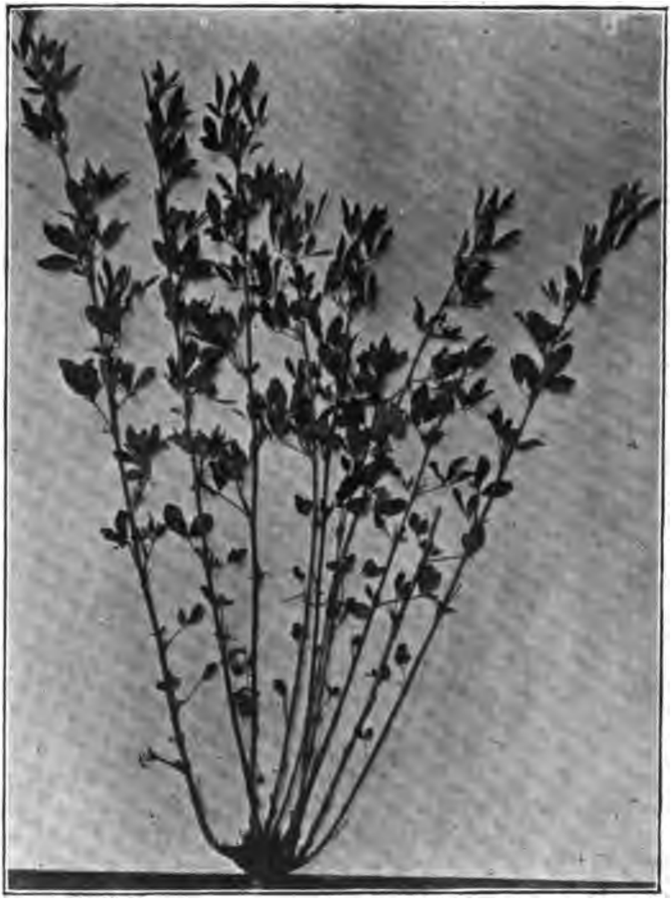

Plate VII—Showing the new growth barely starting when plant is just ready to bloom.

MAKING ALFALFA HAY.

The best alfalfa hay is made by raking and cocking while fairly green and allowing to cure for several days in the cock. On account of the uncertainty of the weather, however, this method is often found impracticable and a quicker method in which the alfalfa is dried in the sunlight must be used. It is always very important that the raking and as much of the other handling of the crop as possible be done while the alfalfa is sufficiently green to retain its leaves, as the leaves are by far the best part of the plant.

A method of handling the crop which has given good satisfaction at the Experiment Station is to cut the alfalfa in the morning as soon as the dew is off, allow it to remain in the swath as late in the afternoon as possible and yet get it raked before the evening dews fall and then put it in tall cocks, if it looks like rain; otherwise leave it in the windrow over night. If the next day is sunshiny the hay is scattered after the dew is off, allowed to dry until late afternoon and put in the barn. If the weather is not favorable for drying, more than two days will be required to cure the hay.

Hay put in the barn or stack when only partially cured is likely to mould or to char and be dusty so that it is practically unsalable, and in some cases sufficient heat is generated to ignite the whole mass.

SUMMARY OF REPORTS FROM ALFALFA GROWERS IN MARYLAND.

In the tabular data below the one hundred twenty two parties who reported that they had good stands of alfalfa at the time of making their reports are classed as successful, though some had grown it only one year, while the thirty-six parties who had tried growing alfalfa, but reported failure, are classed as unsuccessful.

Table showing the Number and Per Cent. of Successful and Unsuccessful Growers in Relation to Certain Treatments.

Treatment of Crop	Successful Parties		Unsuccessful Parties	
	No.	Per Cent.	No.	Per Cent.
Using Manure	91	74.6	15	41.7
“ Lime	66	54.1	10	27.8
“ Com. Fertilizer	57	46.7	15	41.7
“ Com. Fert. and Lime.	39	32.0	7	19.7
“ Manure and Lime	52	42.6	7	19.7
“ Manure and Lime and Com. Fertilizer	33	27.0	6	16.7
“ Nurse Crop	7	5.7	2	5.6
“ Inoculated Soil	41	33.6	7	19.7
Seeding in Fall	82	72.1	13	36.1

While some seedings reported as failures received good treatment and some successful ones poor treatment the table shows that there is a very much larger percentage of the one hundred twenty-two successful growers who practiced certain good treatments, than there is of the thirty-six unsuccessful parties. This is shown by comparison of the third and fifth columns which show that the per cent. of instances in which manure, lime and inoculation were used is about twice as great among the successful farmers as among the unsuccessful.

Manure was used by ninety-one of the one hundred twenty-two successful growers or three-fourths of them, and by less than forty-two per cent. of the thirty-six unsuccessful growers, showing that manuring and success with alfalfa are closely associated.

Lime was used by fifty-four per cent. of the successful parties and by less than twenty-eight of the unsuccessful. None reported any damage from its use, a few reported no benefit and a great many reported very favorably of its value. Doubtless some of those who have not reported using lime had used it on some previous crops. Lime was used at the rate of eight to one hundred bushels per acre, and those who had tried different amounts thought twenty to twenty-five bushels a sufficiently heavy application at one time.

Inoculation was practiced by over twice as large a per cent. (forty-one per cent.) among the successful parties as by the unsuccessful. In this connection it must be remembered that many of the uninoculated successful fields will not be permanent successes, and that there are conditions under which the uninoculated fields may have become inoculated, naturally. These are as follows:

First—Some of the fields may have been so rich and so well prepared that the plants were kept growing vigorously until the few bacteria introduced by the seed or that chanced to be in the soil had time to develop and become sufficiently numerous to inoculate the field.

Second—On many of the fields previous attempts to raise alfalfa had been made so that on the plants which survived sufficient bacteria may have developed to have thoroughly inoculated the soil.

Third—Many of the fields were naturally supplied with bacteria because of sweet clover having grown in the field or on its borders.

Those who have tried inoculation with soil are most heartily in favor of its use.

Fall seeding was practiced by about three-fourths of the successful parties, many of whom had tried both spring and fall seeding and have found fall seeding preferable.

EXPERIENCE OF ALFALFA GROWERS.

Hon. Chas. A. Councilman has been growing alfalfa since 1886 and at the present time has over one hundred acres, sixty-six acres of which were seeded twelve years ago. This old field will average only about a half a stand but when seen by the writer on May 16, was pasturing three hundred fifty hogs, and promised a fair cutting of hay. He seeded a twenty-one acre field to alfalfa in the spring of 1907 which came up very evenly and is looking well. This field, he says, was sown in alfalfa fifteen years ago and the alfalfa plowed up three years ago, since when he has been preparing it for raising the best alfalfa he has ever grown. His method has been as follows: Each of the three years he sowed corn and cow-peas and cut for ensilage, then a heavy coat of manure, about forty loads per acre, was applied and plowed under, the first two years the manure being plowed under in the spring and the last year (1906) the plowing being done in the fall in order to give a more compact seed bed. This spring he worked up the surface with disc and spike-tooth harrows until it was fine enough for a garden. He used a wheelbarrow seeder and covered the seed with a weeder.

His soil is a fairly stiff clay for the first two and one-half feet with the exception of the surface foot, which is in a fine physical cndition because of the organic matter incorporated with it. Below two and one-half feet it becomes more porous because of the fine gravel and sand which appears at that depth. His soil is all underlaid with limestone rock at from two to four or five feet in the large field and four or five feet in the twenty-one acre field.

Mr. Councilman thinks that every farm in the State can be made to grow alfalfa successfully and that the reasons for failures are chiefly because the land has not been properly prepared or the seed put in right. He believes the farmers of this State should grow more legumes, make more manure and use their manure to better advantage in building up the humus exhausted soil so that it will not only produce larger crops of corn and wheat, but will furnish an ideal home for bacterial life and for the growth of alfalfa and red clover. This procedure, together with good tillage, will fit any well drained land for raising large crops of alfalfa.

Mr. Chas. Fairbanks, Royal Oak, Maryland, is growing alfalfa as a rotation crop. His use of the crop for that purpose was accidental and was brought about as follows: Mr. Fairbanks had followed the practice for some time of sowing red clover in wheat early in the spring, cutting it one year for hay and then plowing it under for corn, making a three year rotation of corn, wheat and clover. About eight or ten years ago he sent to Baltimore for red clover seed but unknowingly received alfalfa. He sowed the seed as usual, and secured one good crop of hay that fall and four crops the next summer. The following spring it was plowed up and put into corn. He found that he had what was called alfalfa, but he liked it so well that he has been using it since instead of red clover. He has no trouble in getting a catch and gets much larger yields than he could with red clover. His soil is naturally adapted to alfalfa and, as sweet clover is common about his place, natural inoculation has been thorough.

Mr. E. E. Scott, Western Run, Maryland, sowed some alfalfa in the fall of 1906, using seed inoculated with nitro culture, and on a part of the field applying inoculated soil sent him by the Experiment Station. On July 12, 1907, he reported as follows: The alfalfa came up nicely and made a similar growth on both parts of the field until about a month before the first cutting. Then the portion which was not inoculated with soil turned yellow in spots and at the first cutting yielded not over one-fourth as much as the other portion of the field. Since the first cutting the part not inoculated with soil has improved very much, lost its yellow color, grown more, and I think will yield one-half as much the second cutting as the soil inoculated plot. Nodules are abundant on the soil inoculated portion, but are found only on a part of the plants in the other portion of the field. I consider alfalfa a success, for the soil inoculated plot made me one and one-half to two tons per acre in the one cutting.

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PUBLICATIONS

OF THE

Maryland Agricultural Experiment Station.

These Bulletins are sent free of charge to any address upon application.

Only the Bulletins named below are available for distribution.

Bulletin No.	**31, March,**	**1895,**	**Potato Experiments.**
" "	**38, March,**	**1896,**	**Potato Experiments.**
" "	**50, Sept.,**	**1897,**	**Rust and Leopard Spot, Two Dangerous Diseases of Asparagus.**
" "	**51, Dec.,**	**1897,**	**Horse Feeding. Tests of the Digestibility of Oats, Corn, Hay and the New Corn Product.**
" "	**53, March,**	**1898,**	**Special Investigation of the So-called "New" Horse Disease in Maryland.**
" "	**58, Aug.,**	**1898,**	**The Hessian Fly and Wheat Diseases.**
" "	**61, June,**	**1899,**	**The Sugar Beet in Maryland.**
" "	**63, Dec.,**	**1889,**	Pig Feeding.
" "	**67, June,**	**1900,**	**The Culture and Handling of Tobacco.**
" "	**71, Feb.,**	**1901,**	**Notes on Spraying Peaches and Plums in 1900.**
" "	**72, March,**	**1901,**	**Observations on Growing Peaches in Maryland.**
" "	**73, April,**	**1901,**	**Suggestions About Combating the San Jose Scale.**
" "	**75, June,**	**1901,**	**The Effect of Hydrocyanic-Acid Gas on Grains and Seeds.**
" "	**76, June,**	**1901,**	**Parturient Paresis—Milk Fever.**
" "	**79, Jan.,**	**1902,**	**The Disinfectant Properties of Washing Powders.**
" "	**86, Sept.,**	**1902,**	**The Influence of Preservatives on the Food Value of Milk.**
" "	**87, Nov.,**	**1902,**	**The Periodical Cicada, or Seventeen-year Locust.**
" "	**88, May,**	**1903,**	**Economical Methods for Improving the Keeping Qualities of Milk.**
" "	**89, June,**	**1903,**	**Experiments with Potash Fertilizers.**
" "	**92, March,**	**1904,**	Notes on Apple Growing.
" "	**93, May,**	**1904,**	**Second Report on the Pithiness of Celery.**
" "	**94, July,**	**1904,**	**Methods for Keeping Milk and Butter Records.**
" "	**96, Sept.,**	**1904,**	**Sweet Corn Breeding, Growing and Curing for Seed.**
" "	**97, Oct.,**	**1904,**	**The Relative Profits of Selling Milk, Cream and Butter.**
" "	**98, Nov.,**	**1904,**	**Home Grown Protein for Feeding Cows.**
" "	**99, Dec.,**	**1904,**	**Spray Solutions for San Jose Scale.**
" "	**101, April,**	**1905,**	**Common Injurious and Beneficial Insects.**
" "	**102, May,**	**1905,**	**The Leucocytes in Milk and Their Significance.**
" "	**103, June,**	**1905,**	**Methods of Tobacco Seed Selection.**
" "	**104, July,**	**1905,**	**Tests of Materials for Bedding Cows.**
" "	**105, Aug.,**	**1905,**	**Fumigating Nursery Stock.**
" "	**106, Sept.,**	**1905,**	**Influence of the Size of Corn Grain and Germ upon the Plants.**
" "	**107, Oct.,**	**1905,**	**Spraying Experiments for San Jose Scale.**
" "	**108, April,**	**1906,**	**Irish Potato Diseases.**
" "	**109, May,**	**1906,**	Mosquitoes.
" "	**110, Sept.,**	**1906,**	**Investigations on the Liming of Soils.**
" "	**111, Oct.,**	**1906,**	Oyster Shell Scale.
" "	**113, Dec.,**	**1906,**	**Tomato Investigations.**
" "	**114, Jan.,**	**1907,**	**Fertilizer Experiments with Phosphoric Acid.**
" "	**115, Feb.,**	**1907,**	**Control of Insect Pests and Diseases of Maryland Crops.**
" "	**116, March,**	**1907,**	**Marketing Fruit and Truck Crops.**
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" "	**118, June,**	**1907,**	**Alfalfa in Maryland.**

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OF THE DIRECTOR
OF THE
Maryland Agricultural Experiment Station

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The
Twenty-first
Annual Report.

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VOLUME No. 21
OF THE
Maryland Agricultural Experiment Station,
COLLEGE PARK, MD.
1907-1908.

THE

Maryland Agricultural Experiment Station.

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*On State Horticultural Department Work.

The Station is located on the B. & O. R. R. and City & Suburban Electric Car Line, eight miles north of Washington, D. C.
Bell Telephone—Hyattsville 55 R.

Visitors will be welcome at all times, and will be given every opportunity to inspect the work of the Station in all of its departments.

The Bulletins and Reports of the Station will be mailed regularly, free of charge to all residents of the State who request it.

ADDRESS:

AGRICULTURAL EXPERIMENT STATION,
College Park, Maryland.

THE

TWENTY-FIRST

ANNUAL REPORT

OF THE

MARYLAND

Agricultural Experiment Station,

COLLEGE PARK
PRINCE GEORGE'S CO., MARYLAND.

1907–1908.

PUBLISHED BY THE STATION.

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AGRICULTURAL EXPERIMENT STATION.
College Park, Maryland.

LETTER OF TRANSMITTAL.

To His Excellency, Austin L. Crothers,

Governor, and President of the Board of Trustees,

Annapolis, Md.

Sir:—In accordance with the provisions of Section No. 3, of the Act of Congress, approved March 2, 1887, "To Establish Agricultural Experiment Stations," etc., I have the honor to transmit the Twenty-first Annual Report of the Maryland Experiment Station for the fiscal year ending June 30, 1908.

Very respectfully yours,

H. J. PATTERSON,

July, 1908. Director of the Experiment Station.

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THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

Volume 21. 1907-1908.

Report of the Work and Expenditures of the Maryland Agricultural Experiment Station.

FOR THE YEAR ENDING JUNE, 1908,

BY H. J. PATTERSON, Director.

To the Honorable Board of Trustees of the
Maryland Agricultural Experiment Station.

GENTLEMEN: I have the honor to submit for your consideration a report upon the work of this institution for the fiscal year just ending, and an outline setting forth the most important facts relating to the existing status and policy of the Station and the new lines of work which have been taken up since the last annual report.

THE FUNCTIONS OF THE STATION.

The past year has marked a decided broadening of the scope of the investigations and an increase in the equipment and facilities for conducting the same. The condition of the Station and its equipment is in the main gratifying and satisfactory to the Station workers; yet it is to be said that this institution is relatively in its infancy and still in the process of development and therefore real needs exist which must be supplied from time to time if there is to be progress in equipment and organization so as to make this institution an efficient factor in ministering to agricultural ills and a leader and moulder of advanced agricultural thought.

The question as to the range of the work that the Station should undertake to do is an ever-recurring one. Theoretically its primary office is to establish facts and principles that shall serve as a safe guide for conducting and developing agricultural practice. The effort cannot stop with this however. It is equally the duty of such an institution to suggest new applications of knowledge, verify conclusions in relation to agricultural practice and disseminate the results of its investigations.

All this is being done in some measure and the continued approval of the Station efforts by the agricultural public is a reasonable assurance that the work is regarded as helpful. Nevertheless it is sometimes doubtful whether the real functions of the Station are not being encroached upon, and too much time being devoted to what is truly demonstration work and teaching of a popular character. This latter class of work is highly valuable and essential, but ought to be provided for more liberally by State funds and done in such a way as to not interrupt the work of the investigators.

It is very certain that the members of the Staff cannot properly and successfully carry on important investigations and experiments unless they can give to such work their uninterrupted attention through a large portion of the year, a fact that is not fully appreciated by those without experience in studying scientific problems.

Popular teaching is important and highly essential, but belongs properly to the functions of the College, its farmers' institutes and agricultural extension. The discovery of facts and principles by careful and severe inquiry so as to establish knowledge and place it on a basis for popular teaching constitutes the paramount work of the Experiment Station.

It needs but a glance at the progress of agriculture in the United States during the past twenty years to show the powerful influence of a few important discoveries. The Station workers who have established truths of general importance stand in the front rank of agricultural benefactors. As long as there are so many important problems unsolved and the Station is the recognized agency in each State for research, it would seem desirable for it to confine its best efforts to its special field.

PUBLICATIONS.

The investigations which have been completed or advanced sufficiently to warrant a report of progress have been printed in bulletin form and are covered in the following list which has been issued during the past year:

No. 119. July, 1907—Greenhouse Pests, by A. B. Gahan, pp. 1 to 36.

No. 120. August, 1907—Sweet Corn Investigations, by M. N. Straughn, pp. 38 to 78.

No. 121. September 1907—Beef Cattle Industry of Maryland, by B. E. Porter, and the Cost of Growing Beef Cattle, by H. J. Patterson, pp. 79 to 116.

No. 122. October, 1907—Stable Manure Experiments, by W. T. L. Taliaferro and H. J. Patterson, pp. 117 to 138.

No. 123. November, 1907—San Jose Scale, by T. B. Symons and G. P. Weldon. The Peach Lecanium, by A. B. Gahan, pp. 139 to 160.

No. 124. December, 1907—Strawberries, by C. P. Close, W. R. Ballard and T. H. White, pp. 161 to 195.

HORTICULTURAL OFFICES, LABORATORIES AND GREENHOUSES.

No. 125, February, 1908—Nut Growing in Maryland, by C. P. Close, pp. 196 to 217.

No. 126, April, 1908—Manuring and Fertilizing Truck Crops, by C. P. Close and T. H. White.

No. 127, May, 1908—Experiments with Miscellaneous Vegetables and Fruits, by C. P. Close, W. R. Ballard and T. H. White.

No. 128, June, 1908—Effects of Digestion and Fermentation of Manure on the Vitality of Seeds, by E. I. Oswald.

STATION STAFF.

There has been two changes in the Station Staff during the year both of which were caused by resignations which took effect January 1. The position of Assistant Chemist caused by the resignation of Mr. J. J. T. Graham has been filled by the appointment of L. B. Broughton, a graduate of this College in the chemistry course in this year's class.

BUILDING.

The equipment of the Station has been enlarged during the past year by the addition of a new dairy barn, a new building for the horticultural offices and laboratories, three new greenhouses, an incubator house and laboratory for poultry investigations and poultry houses. Pictures of these buildings are included in this report.

INVESTIGATIONS.

The outline given in the following paragraphs is not intended to give a complete list of the investigations now under way or to indicate the activities of the several departments; but is intended only to supplement former reports and bring to your attention such new matters as are receiving consideration and which it may be desirable to take up in the near future.

AGRONOMY DEPARTMENT.

The work now being conducted by this department is the same as outlined in the 20th annual report. It is hoped that facilities may soon be available so as to broaden the scope of the work of this division considerably, and make it cover more completely a wider range of territory and also take up work with all the cereals and more forage crops. The work of this department has been interrupted considerably by the resignation on January 1 of Mr. V. M. Shoesmith.

The work outlined for this season is as follows:

CORN.

1. Breeding of Leaming & Munnikhuysen corn.
2. Testing of the degree of inbreeding or close breeding, which may be safely practiced.
3. Testing Leaming seed from different sources.
4. Variety tests at the Experiment Station including 17 varieties.
5. Cooperative variety tests with 40 farmers in different parts of the State. Five of these tests include six or more varieties and the rest include the Leaming corn and one or two local varieties.

WHEAT.

1. Breeding plots of Currell and Fultz.
2. Variety and selection tests including 26 plots of 1-20 acre, 22 of 1-40 acre and 47 of 1-80 acre, besides 134 smaller plots used mainly for increasing the amount of seed.

COWPEAS.

1. Breeding plots of three varieties.
2. A variety test.
3. A study of the methods of harvesting and threshing cowpea seed.

ALFALFA.

1. Breeding.
2. Testing seed from different sources.
3. Fertilizer tests.
4. Methods of preparation of seed-beds.
5. Cutting experiments.
6. Culture experiments.

CLOVERS—RED, MAMMOTH, ALSIKE AND WHITE.

1. Breeding.
2. Tests of seed from different sources.

GREENHOUSE WORK.

1. Growing of plants of several varieties of cowpeas to be used as material for breeding and study.
2. Growing of selections of alfalfa and clover made from field breeding plots in 1907.
3. Fertilizers on alfalfa.
4. Fertilizers on red clover.

NEW WORK.

The work outlined above is mainly a continuation, on a larger scale in some cases, of the work in progress during the season of 1907. Other experiments relating to the same lines will be undertaken later in the season, if circumstances will permit.

A line of new work deserving more attention by this department as soon as the funds are available, is the variety testing and breeding of corn, wheat and other crops in those parts of the State where the climatic and soil conditions are much dissimilar to those at the Station farm. These parts are Maryland west of the Alleghanies, the Piedmont region and the Eastern Shore of Maryland. Some good cooperators among the farmers are found on the Eastern Shore and work there for a time at least should be confined to cooperative work, but in the other two sections of the State the farmers are less alive to the work of the Station and in each of these sections arrangements should be made to secure by lease or otherwise, the use of four or more acres of land adapted for experimental purposes. The work for the first year should include a variety test of eight or ten of their local varieties of corn and wheat, and as many more standard varieties from outside sources. Other crops special to that part of the State, such as buckkwheat and oats in Western Maryland might also be included in the test. As soon as possible all but two or three of the best varieties of each crop should be eliminated and these improved by breeding and selection. As soon as a desirable breed is obtained of any crop, seed from it should be planted in increase plots so as to get seed for dissemination among the farmers. This work would bring the Agronomy department in close touch with the farmers in those sections and give better opportunities for extending cooperative work.

Another piece of outlying work that might be undertaken is a variety test of corn at one or two points where the farmers do not believe that the type of corn recommended by the Station makes as good yields as the type they are growing. The test might include ten varieties popular with the farmers and ten varieties chosen by the Station. The purpose of this experiment would be to show the comparative yield of the varieties at husking time, by weight and by measure. To show the comparative yields of the corn when weights are taken in February or March, both of corn on the ear and corn shelled, and to show the percentage of shelled corn of each. Fifty-pound samples should be saved of each variety at husking time for making the latter determinations.

A study of the dominance of color characters and the flint, dent and sweet characters of corn to test the principles brought out by Mr. East of the Connecticut Experiment Station in his report for the year 1907, should if possible be started this fall. This test requires four seasons. All the crosses are made the first year. The remaining seasons the ears are planted in separate rows and the corn self-pollinated by hand.

An attempt will be made in the greenhouse to breed up a more acid resistant alfalfa. This will be done by filling one of the solid beds of the greenhouse with acid soil and trying plants of different varieties there. Seed of the most resistant plants will be saved for the second planting. The unlimed strip south of Agronomy building will furnish suitable soil for this purpose.

BOTANICAL DEPARTMENT.

The work of this department for the past year has been mainly a continuation of that outlined in last year's report. There has been a very large number of samples of seeds, especially clover and alfalfa, submitted for the determination of their purity and vitality. The clover has shown an unusual amount of Dodder and other European weeds.

An investigation has been begun with the value of self-boiled lime and sulphur spray for plant diseases.

This department desires to pursue during the coming year a study of The Effect on Plant Structure and Physiology of the Internal Application of Different Substances, with the end in view of determining:

1. How plants are killed or injured by the application of chemicals.
2. May any substance so introduced affect the resistance or susceptibility to disease.
3. Can nutrition be so supplied.
4. The path and movement of substances in plant tissues.

Economic Problems Upon Which the Work May Bear.

1. The eradication of weeds.
2. The injury of plants by sprays.
3. The injuring of plants by strong fertilizers.
4. Killing worthless trees and shrubs.
5. The control of plant diseases.
6. The variation in vigor or vitality of different individuals or varieties.
7. The transfer of vital characteristics from one plant to another by transfer of juices.
8. Application of nutrition to plants with poor or diseased root system.
9. Additional water supply to such.
10. Additional nutrition to plants grown under intensive cultivation for quick production of large growth.

CHEMICAL DIVISION.

The greater part of the time of this division during the past year has been consumed in the studies of the pathological and physiological nature of milk. This work consumed almost the entire time of one man. The sweet corn investigations together with the miscellaneous samples and routine work of investigations outlined in previous reports took up the time of the second assistant chemist.

DAIRY INVESTIGATIONS.

The dairy investigations now under way can be divided into two classes: 1st. Those which relate to the production of milk and a study of all the factors which influence its value as food. 2nd. A study of the conditions surrounding the making of butter in Maryland with a view of determining the reasons for lack of uniformity in quality, so that ultimately directions may be given which will enable the creameries of Maryland to make as good and uniform a quality of butter as is now supplied by the Northern and Western districts that command the best prices in our markets.

ENTOMOLOGICAL DEPARTMENT.

The investigations being pursued by this department may be summarized under the following heads:

I. Fumigation of buds in the nursery with hydrocyanic acid gas.

(Tests to determine the maximum strength of gas that the buds will stand without injury and the least amount that will be effective in killing the San Jose Scale.)

(This has continued for two years.)

II. Dipping nursery trees in different insecticides.

(To ascertain the effect of such treatment on the stock after being planted in the field and also the effectiveness of treatment in controlling San Jose Scale.)

(Continued for two years.)

III. Testing different insecticides for the control of San Jose Scale on orchard trees.

(The numerous inquiries in regard to the effectiveness of the many new solutions that appear on the market makes it advisable to determine actual facts in regards to their ability to control the pest.)

IV. Treatment with arsenate of lead (different brands) and paris green to control the Codling Moth. Study of life history continued.

V. Treatment with arsenites for the control of the Plum Curculio.

(This investigation was commenced in 1906, but climatic conditions has prevented much work being done.)

DAIRY BARNS.

VI. Treatment with arsenites for the control of the asparagus beetles.

(There is no practical means of combating these beetles and it is hoped that a persistent syraying with arsenites on old beds will be found advantageous.)

VII. Tests with different materials in an effort to secure a good and practical repellant for the flea beetles, rose bugs, etc.

(It is possible that a repellant may be found to prevent injury from the flea beetles. These pests cause much injury to many of our truck crops.)

VIII. Miscellaneous.

(Continuation of the studies of the life history of the Oyster Shell and Scurvy Scale insects. Continuation of the work on the mosquitoes of the State with experiments with different larvacides. Tests of methods for combating the Peach Tree Borer.)

IX. Study of the parasitic Hymnoptera with special reference to the family Braconidae.

HORTICULTURAL DEPARTMENT.

The investigations being conducted in this department are a continuation of those outlined in last year's report, with the addition of many new projects. The enlargement of the greenhouse facilities will make it possible to take up some new investigations with the growing of flowers and vegetables under glass. The results of all of the investigations completed up to this time have been issued in bulletin form during the past year:

The following lines of work are now being pursued:

Truck crops in young apple orchard—E. P. Cohill—seven one-half acre plots, one plot each of sweet corn, sweet potatoes, Irish potatoes, muskmelons, tomatoes, strawberries and one check.

Variety peach orchard—E. P. Cohill, Hancock, Md.—About 100 varieties for testing.

Variety peach orchard—W. F. Allen, Salisbury—About 100 varieties for testing.

Apple breeding—About 700 blossom clusters were crossbred, using summer varieties together and two winter varieties together. Of the seed secured in 1907 there are now 510 seedlings growing. These were started in the greenhouse.

Pear breeding—About 500 blossom clusters were crossbred this year. This is an attempt to combine the hardiness, vigor and productiveness of the Kieffer with the good qualities of the Seckel, Anjou, Duchess, etc.

Spraying with different strengths of Bordeaux to determine weakest strength which will hold the apples to the trees. In connection with this test two poisons of two different strengths are used against the codling moth by the Entomologist.

Cover crops in Station orchard.

Mulching strawberries.

Mushroom growing—Test of varieties, fertilizers and mulching. This was a failure because the uncovered steam pipes running through the room kept the temperature too high.

Dwarf pear and apple orchard—to be budded to the seedling apples and pears in the breeding work.

Pap paw—Growing seedlings and improved varieties.

New raspberry plantation—To test distances of planting and pruning and training.

Effects of fertilizers on the structure of plants.

Variation of plants by excess of food fertilizers in various forms.

Commercial fertilizer and cover crops in apple orchard—W. G. Dawson.,

Commercial fertilizer and cover crops in apple orchard—E. P. Cohill.

Commercial fertilizer and cover crops in apple orchard—W. F. Allen.

Variety test of geraniums to test resistance to disease, hardiness and vigor of plant.

Experiments in preserving strawberries and other fruit especially with a view of retaining the color.

Pollination studies with apples and pears.

Recording the leafing and blooming periods of apples, peaches, plums, pears, blackberries, raspberries, strawberries, currants and gooseberries.

Picking, weighing and recording yields of orchard and small fruits.

Application of copper sulphate solution to soils planted to tomatoes to test its effect in rendering plants immune to disease.

Testing varieties of tomatoes, sugar corn, cabbage and Irish potatoes.

Testing rust-proof Rocky Ford cantaloupes.

Planting sweet potatoes continuously on same soil.

Testing potato seedlings.

Fertilizer experiments on asparagus.

Varieties of violets with investigation into their requirements as to soils and fertilizers.

Continuation of experiments with carnation cuttings in relation to the vigor of the plants.

Commercial fertilizer on truck crops.

Improvements of varieties of strawberries by seed selection.

NEW WORK.

Distribution of 912 Persian walnut and pecan trees—433 of these are in 13 test nut orchards of 20 to 50 trees, in 12 counties. Seventy-five nut trees were planted on the Station and College grounds which with the few trees distributed in College Park make 1000 nut trees planted through the efforts of the department.

Grafting Persian walnuts—285 were root grafted on one-year seedling black walnuts and Persian walnuts. A few limbs of black walnut were grafted to the Persian.

Grafting black walnuts on black walnut seedlings.

Budding Persian walnuts on black walnut limbs.

Planting nuts—3 bushels of black walnuts; No. 20 San Jose Persian; No. 30 Franquette; No. 6 Cumberland; No. 2 Peerless and No. 10 Maryland grown nuts.

Pruning pecans—Ordinary long root pruning vs. stub pruning.

Saving seed of varieties of cabbage resistant to disease and extremely unfavorable conditions.

Saving seed of Golden Self-Bleaching Celery and testing against California-grown seed.

Potatoes—Investigations into causes affecting yields of Irish potatoes:

1. Home grown seed of several varieties against Maine grown and second crop Virginia seed.
2. Eyes cut from "stem" end, and also from "seed" end and planted separately.
3. Tubers selected from several varieties that show very weak sprouts when allowed to sprout before planting as against selected tubes with strong sprouts.
4. Various sizes of tubers cut and uncut.
5. Tubers from which all sprouts have been removed just before planting as against those with sprouts left on.

Geranium breeding.

(a) Production of bedding varieties adapted to Maryland conditions.

(b) Application of Mendel's law.

(c) A study of color relations.

(d) Hybridization.

Selection work with pansies.

An experiment to test the rooting of cuttings, of a number of varieties of apples.

Effect of fertilizers on the growth of cabbage when applied to the land in the spring as against an application just before planting at midsummer.

Effect upon the growth and maturity of cabbage when the plant beds are supplemented with excessive amounts of the different plant foods.

NEW WORK IN GREENHOUSE.

Methods of Ventilation as related to the prevalence of mildew on roses.

Effect upon the growth of roses, carnations, chrysanthemums and violets, when the manure used is obtained from cattle that are bedded with sawdust, litter or no bedding.

Improvement of carnations by selection of seedlings produced by self-pollination.

An investigation into the causes of doubling of various plants especially as to pruning and manuring.

Effects of excessive amounts of Gypsum, lime (caustic), sulphur, iron filings, copper sulfate, phosphoric acid soluble and insoluble, dried blood, muriate and sulfate of potash upon the variation of tomatoes.

Variety testing of chrysanthemums, tomatoes and English muskmelons.

POULTRY INVESTIGATIONS.

The investigations with poultry as previously outlined may be divided into two classes, viz: Commercial problems and studies on incubation and poultry diseases. The former tests are being conducted by Mr. C. L. Opperman and the latter by Dr. Robert Mayo. Dr. Mayo worked on these problems for three months last summer, and will resume the studies again on June 1, under the plan which has already been approved by this board. The following is an outline of the commercial problems now in progress:

The first five months of the year was devoted to raising stock and getting the buildings into shape for experimental work. There was practically no real research work done except the keeping of the records of the fowls on hand, and some metereology tests in the incubator cellar. These records have been carefully filed away and will be compiled some time during the year, and if anything of value is found it will be used in a bulletin.

During the latter part of October preparations were begun for starting a general test of poultry houses, to ascertain if possible what type of house is best adapted to Maryland's climate. There were about 300 pullets reared for this experiment. They were carefully weighed, leg banded, and selected so that each type of house would have practically the same number of pounds of live weight and the same number of fully developed birds of the same age. Considerable care was exercised to have these conditions as near exact as possible.

This experiment was started November 5, 1907, and has been progressing very favorably to the present date.

All fowls are trap-nested, and the records of each individual hen is carefully kept. All the feed that is used by each type of house is carefully weighed, and a record kept of the same. During the months of November, December, January and February the temperature and humidity of the houses were carefully recorded each day. In the houses that are equipped with the hooded roosts, the difference in temperature between the roost and the outside pen was carefully recorded.

In connection with this experiment considerable incubation and brooding work is being done to determine what effect the type of house has on the fertility of the eggs, the strength and vitality of the young chicks. To carry out this work the Department secured six Model Incubators, and twelve indoor Prairie State Brooders, which have given good satisfaction. There has been incubated from each pen 300 eggs, making a total of 1800, from which has been secured 924 chicks. Careful records of the incubation and brooding are being kept. From the last hatch which was made in April, twenty pullets from each type of house will be reared. During the latter part of October the twenty poorest hens in each type of house will be taken out; these will be replaced by the pullets reared during the summer. This will give data on the effect on the next generation while work is continuing with the first generation. This experiment will be carried on practically the same next year, with the addition of any points that will make it more efficient.

THE EFFECT OF WET AND DRY MASH ON EGG PRODUCTION WITH TWO-YEAR-OLD HENS.

This experiment was started on December 4, 1907, and continued until April 8, 1908. The experiment consisted of two pens of fifteen fowls each. One pen received grain morning and evening, with a warm mash at noon. The other pen received grain morning and noon, with dry mash before them at all times. Records were kept of all the food consumed, and the eggs produced by each pen. The general health of the fowls was observed from time to time.

THE BREEDING OF BARRED PLYMOUTH ROCKS FOR EGG PRODUCTION.

During the early part of the summer the Department, through the kindness of Mr. McGrew, of Washington, secured 60 eggs from birds that had attracted attention by their remarkable egg production. From these eggs only 10 pullets were secured. Records of the work of these hens are being kept and the eggs used for increasing the stock for further experiments.

VETERINARY DEPARTMENT.

The work of this department for the past year has been of a diversified nature, owing to the construction of new barns and the necessary abandonment of the old structure in the early part of the year. The milk investigations begun two years ago, and from which the microscopical studies indicated important chemical changes under certain conditions, have been fully borne out by subsequent chemical examinations. It is important now that these examinations (micro-

POULTRY HOUSES AND LABORATORIES.

scopical and chemical) be carried along together, in order to perceive their fullest significence.

The bacteriological studies are not to be disregarded, but just now the important work is microscopical and chemical until a knowledge of all milk constituents is had; later bacteriological and other conditions can be taken up to determine their influence upon such constituents.

The histological study of the cow's udder was begun for the reason that no satisfactory information was available upon this very important organ, and milk studies without such knowledge would be superficial. There has recently been published from Europe, what appears to be a very carefully prepared contribution to this subject, which doubtless, will serve most purposes for milk studies. The especial study of blood and lymph vessels is, however, necessary.

In addition to the milk work there have been made a number of tuberculin tests and vaccinations. The value of tuberculin is shown to be dependent upon proper administration, and carelessness in this respect has tended to discount its real value in many instances. A full discussion of this subject will be given in a report which is in preparation.

The introduction of bills on three subjects at the last session of the General Assembly, all of which failed to pass, makes it important to enter at once upon a study of the needs of such legislation and the extent to which it should be carried as well as the probable effects. Two of these bills originated with the State Board of Health, the third from a dairy interest. The subjects, rather than the bills, should be considered, and are (a) Meat Inspection, (b) Milk Inspection, (c) Tuberculosis.

The report of this department in 1896 suggested an inquiry into (1) Cooperative Slaughter-houses in various parts of the State, whereby the producer could realize the greatest returns from his animals; (2) the investigation of Cerebrospinal Meningitis in horses; (3) Cooperation with the State in investigating sanitary conditions, and aid in perfecting them.

These recommendations are just as appropriate after a lapse of twelve years. The Board of Health bill on slaughter-houses was drafted primarily to safeguard the health of the State by regulating the practice of slaughtering, transporting, keeping and selling meats for human food. The producers of food-producing animals would receive greater returns for their animals if slaughtered at central points where offal could be utilized. Inspection could be practiced with profit, and no one injured by the adoption of such central slaughtering points. However, it proved unwise to seek legislation before existing conditions and practices were known as the fate of the bill shows.

Cerebrospinal Meningitis investigations have been made when ever the disease appeared, with profit, and the work of this Station in connection with Johns Hopkins Medical School has placed the pathological knowledge of this disease on a higher plane than it ever before held in this country.

The cooperation in sanitary matters has not been extensive, but should be. In justice to the farmer, our Station should closely study the laws and regulations which are constantly thrown around his work and the products of his work, in order to protect him against unwisely imposed regulations that have no real value and to aid him in securing proper returns for expenditures incurred in wise regulations made necessary for the public good. This subject is important and should be carefully studied. Upon it depends Tuberculosis control, Milk and Meat Inspection, and Pure Food control. In this particular, also legislation was asked without actual knowledge of existing conditions.

The time of one person could very profitably be spent in touring the State to collect information upon the cost of production of meat and milk, upon the conditions surrounding the production of these, the location, number, size and general information of the topics above referred to.

Studies of combinations of food materials, with and without condiments is important, and a search for some cheaper substances not regarded at present as food stuffs should be made. While practically all by-products of food are utilized, yet high prices for foods and moderate prices for animal and dairy products still prevail.

COOPERATIVE EXPERIMENTS.

The Station continues to cooperate with the United States Department of Agriculture in all the lines of work given in the last annual report, and in addition to those has taken up some work with the Forestry Bureau on the treatment of fence posts so as to preserve them and lengthen their life and at the same time make it possible through this treatment with preservatives to use many of the abundant and cheap woods that are not used at present. There are 19 different native woods being used in this test.

COOPERATIVE TOBACCO EXPERIMENTS

WITH THE

UNITED STATES DEPARTMENT OF AGRICULTURE.

Tobacco growing has been the important farm industry of the larger part of Southern Maryland since the settlement of the Colony. For many years, however, the industry has not been sufficiently profitable to bring about a reasonable degree of prosperity. A number of causes have brought about this condition.

Men qualified to pass judgment very readily concede that any of the standard crops of Southern Maryland could profitably be made to produce double the yield, on the average, which they now do.

The methods of the past have been such as to diminish and finally exhaust the crop-producing power of the soil. Those of the future must build up and increase its crop-producing power. The tobacco growers' problem cannot be handled adequately without dealing to a considerable extent with the other crops to be grown in rotation with tobacco. This is the key to the situation. The success of the tobacco crop itself depends quite as much upon the crops grown and treatment given the fields in the interim between the successive crops of tobacco as upon the attention given the tobacco itself. By the development and introduction of the very best methods of fertilization, cultivation and handling of the crops grown or desirable to be grown in rotation with tobacco, it is believed that the soil can not only be put in much better condition for producing profitable crops of tobacco, but they can also be made of such greatly increased importance and value as to add very materially to the income of the farm, and in a sense, therefore render the farmer less dependent upon tobacco.

The soils humus content must be built up by growing more leguminous and forage crops and growing them in systematic rotation with the more exhaustive crops like corn, wheat and tobacco.

Much is yet to be learned concerning the best use of commercial fertilizers. When adequately supplemented by humus crops there is but little question that they can be used to much greater advantage than at present, particularly in connection with the production of the tobacco crop itself.

Good seed is another important detail for successful farming. It is now becoming generally recognized that there is as much in improved strains of seed as there is in improved breeds of live stock. Every tobacco grower for example, wants the most productive and best strains of tobacco seed which it is possible to obtain.

Economic conditions are now radically different from what they were in ante-bellum days. Farming methods which were reasonably effective in those days of cheap land, large plantations, and a plentiful supply of cheap labor are no longer satisfactory. The cost of living is also much higher and the price of nearly everything the farmer purchases is more costly. In order to achieve success under these changed conditions, farming methods must be placed upon a much more efficient basis.

The above remarks are intended to throw light on the purpose of the experimental and demonstration work which is being conducted at Upper Marlboro, on the Fair Grounds and on the field belonging to Mr. Frederick Sasscer, back of the Chesapeake Beach Railway Station. The experiments at each place are virtual duplications of each other, but they are upon quite different types of soil.

There are three main features to this work:

1. The plot test experiments with fertilizers;
2. The crop rotation demonstration plots, possessing some important experimental features; and
3. The tobacco breeding work which has for its object the securing of better and more productive strains of seed.

The fertilizer plot experiments on each field consist of eighteen-twentieth acre plots, each receiving a different application of fertilizer. Some of the plots contain ammoniates alone, others phosphates and some potash only. There are also plots containing combinations of each two of these fertilizing materials and others containing all three in varying combinations and amounts. It is proposed to duplicate these experiments in succeeding years on different soils and locations, so that finally there will be accumulated for the benefit of tobacco growers a large amount of valuable data as to the very best practice in the use of fertilizers in Southern Maryland. These plots will be carried through the entire crop rotation. The rotation, as at present proposed, covers five years and consists of tobacco, followed by wheat, then grass for two years, followed by corn with crimson clover and then back in tobacco again on the sixth year. From these small plot experiments it is expected to gain very much valuable data as to the efficacy of the combined effect of the different fertilizers used and the crops grown in rotation, on the permanent improvement and fertility of the soil.

These fertilizer experiments include another very important feature. There is a general opinion prevalent that the use of lime on tobacco soils is harmful and prejudicial to the best interests of the tobacco grower by injuring the quality of the leaf produced. On the other hand it is generally known that lime increases the yield of tobacco and is also very beneficial to most of the other crops grown, particularly the legumes and timothy, and all things considered it is perhaps still uncertain whether the use of lime on soils to be used periodically in tobacco is desirable or not. There is also perhaps some ground for believing that the effect of lime on quality and the price actually obtained for the tobacco is not as adverse as is generally supposed. To throw light on this point one-half of each of the fertilizer plots has been treated to an application of one ton of slaked oyster shell lime per acre. From this experiment there should result a large amount of valuable data as to the real effect of the lime on the quality and yield of the tobacco produced under a great variety of fertilizer conditions. The effect of the lime on all the other crops of the rotation can also be accurately measured. This feature of the experiment alone, if it shows that lime is not as harmful to quality as generally believed, ought to be worth thousands of dollars to the people of Southern Maryland.

Supplementary to these more elaborate small plot experiments there are also on each field a series of five, one-half acre plots on which the proposed rotation will be conducted more nearly upon a field scale, using the best methods known, including those which the smaller plot experiments demonstrate to be best. These plots are designed for object lesson purposes although it is certain that much valuable data will also be obtained under conditions approximately on a field scale, as to the possibilities of Maryland soil under systematic rotation with intensive methods. Aside from an increased yield of tobacco it is expected that there will also result very great improvements in the yield of the other crops, particularly the grass. In experiments similar to these, conducted in Virginia, it was found possible under the system followed to produce really enormous yields of first-class hay instead of the usual almost complete failure under the system generally practiced.

In one case at Appomattox, Virginia, in 1907 the yield was as high as 5.06 tons of cured hay at a single cutting, and the same field again yielded 3.7 tons at the first cutting in 1908. It is believed that many of the soils of Southern Maryland are capable of producing equally good results.

Work for the improvement of the tobacco itself by breeding and seed selection has already been under way in Maryland for several years. It is believed that some improved strains of seed have already been secured, small quantities of which were sent out to about three hundred Maryland farmers this year. This seed work will be activcly continued and a portion of both fields at Upper Marlboro are devoted to breeding work, and to testing out on good sized plots the best of the strains and varieties which have been secured. As the years go by we expect to be able to supply growers with small quantities, enough for a start, of constantly improving strains of seed which will be of great value in producing larger and more uniform crop of better tobacco.

The above represents a brief statement of the more fundamental and clearly defined objects of the experiments which are being conducted. As the work progresses, however, there will naturally be many of the more detailed questions of cultivation, combating insect pests, curing, and handling which will incidentally be studied and valuable information secured and published.

In every possible way, so far as the funds available will permit, it is the purpose of those conducting the work to be of service in spreading the gospel of better farming for the tobacco growers of Southern Maryland.

The locations of Upper Marlboro were chosen because of their easy accessibility to all portions of Southern Maryland and it is believed that the two soil types upon which the experiments are located are fairly representative of the soil conditions throughout most of the tobacco growing section.

There is also some work on varieties of tobacco and fertilizers in progress at Chaney in Calvert County, and at La Plata in Charles.

PROPERTY LINES.

For the past 20 years there has been more or less doubt as to the lines of property between the College Park and Lakeland subdivisions and in accordance with your instructions all of the data as to previous surveys has been secured and this was placed in the hands of Edward Latimer, for many years County Surveyor, and he has run the lines and established the corners so that the property can be properly fenced in accordance with your instructions. Two-inch pipe, 3 to 4 feet in the ground, has been placed at all of the angles and stones will be located at the principal points. The fencing of this land will add a considerable area to the pastures and prevent any encroachment upon College property by the development of the above subdivisions.

FINANCIAL CONDITION.

As appears from the report of the treasurer the finances of the Station are in good condition and the year's work has been carried on within the funds available and small balances remain. It has been the general policy of this institution to run on practically a cash basis and contract no debts that cash was not on hand to meet at once. All bills are settled in full at close of each month, and where discounts are allowed for cash in 5 to 10 days they are availed of.

With the improvements in the character of work of all the departments and the general expansion which has been taking place during the past year, the expenses have increased very materially. The increased cost of labor and all materials has also added considerable to the usual calls for money. While larger amounts of money could be efficiently and profitably used, it is felt that the constituency of the Station should be given convincing evidence that the present appropriations are being used to good advantage before asking for any further increases.

HATCH FUND.

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES APPROPRIATION.

Dr.

1908.

To receipts from the Treasurer of the United States, as per appropriations for the fiscal year ended June 30, 1908, as per Act of Congress March 2, 1887..............$15,000 00

Cr.

1908.			
June 30,	By	Salaries	$8,835 68
	"	Labor	2,592 00
	"	Publications	5 00
	"	Postage and Stationery	267 27
	"	Freight and Express	456 35
	"	Heat, Light and Water	615 07
	"	Chemical Supplies	35 55
	"	Seeds, Plants and Sundry Supplies	147 38
	"	Fertilizers	52 69
	"	Feeding Stuffs	604 11
	"	Library	114 31
	"	Tools, Implements and Machinery	301 25
	"	Furniture and Fixtures	210 54
	"	Scientific Apparatus	128 97
	"	Live Stock	85 00
	"	Traveling Expenses	418 06
	"	Contingent Expenses	15 00
	"	Buildings and Repairs	114 77
		Total	$15,000 00

The above is a true copy from the books of this office.

(Signed) JOSEPH R. OWENS,

Treasurer Maryland Agricultural Experiment Station.

ADAMS FUND.

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES APPROPRIATIONS.

DR.

1908.

June 30, To receipts from the Treasurer of the United States, as per appropriations for the fiscal year ended June 30, 1908, as per Act of Congress March 16, 1906...........$9,000 00

CR.

1908.			
June 30,	By	Salaries	5,251 31
	"	Labor	970 20
	"	Postage and Stationery	9 95
	"	Heat, Light and Water	113 54
	"	Chemical Supplies	426 50
	"	Seeds, Plants and Sundry Supplies	106 53
	"	Feeding Stuffs	780 48
	"	Library	122 54
	"	Tools, Implements and Machinery	182 94
	"	Furniture and Fixtures	55 78
	"	Scientific Apparatus	535 43
	"	Live Stock	2 50
	"	Traveling Expenses	81 30
	"	Building and Repairs	361 00
		Total	$9,000 00

The above is a true copy from the books of this office.

(Signed) JOSEPH R. OWENS,

Treasurer Maryland Agricultural Experiment Station.

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE STATE OF MARYLAND APPROPRIATION.

DR.

1907.	
July 1, To Cash Balance	$3 52
1908.	
June 30, To Receipts from State Treasurer:	
($5,000 bal. on Appr. of 1907)	
($7,500 on acct. of Appr. of 1908)	12,500 00
	$12,503 52

CR.

1908.	
June 30, By Repairs	$2,846 27
" Publications	2,591 57
" Exhibits	571 78
" Feeding Experiments	1,927 66
" Tobacco Experiments	780 60
" Poultry Experiments	2,020 84
" Insurance	241 60
" Trustees' Expenses	266 58
" Labor	529 40
" Seed, Plants and Sundry Supplies	70 28
" Tools, Implements and Machinery	62 15
" Library	128 70
" Travel	38 30
" Balance	427 79
Total	$12,503 52

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE STATE OF MARYLAND APPROPRIATION FOR HORTICULTURAL INVESTIGATION.

Dr.

1907.			
July 1,	To Cash Balance	$498	22
Oct. 1,	To Receipt from State Appropriation 1907	4,000	00
1908.			
Apr. 15,	To Receipt from State Appropriation 1908	4,000	00
		$8,498	22

Cr.

1908.			
June 30,	By Salaries	$680	00
"	Labor	439	52
"	Seed, Plants and Sundry Supplies	858	05
"	Travel	233	98
"	Buildings and Repairs	2,392	69
"	Tools, Implements and Machinery	643	52
"	Freight and Express	96	29
"	Postage and Stationery	40	36
"	Fertilizers	49	68
"	Library	12	00
"	Furniture and Fixtures	54	89
"	Heat, Light and Water	42	85
"	Balance	2,954	39
		$8,498	22

The above is a true copy from the books of this office.

(Signed) JOSEPH R. OWENS,

Treasurer Maryland Agricultural Experiment Station.

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE STATION FARM.

Dr.

1907.		
July 1,	To Balance	$1 20
1908.		
June 30,	To Sales of Stock and produce during year	5,766 59
		$5,767 79

Cr.

1908.		
June 30,	By Labor	$3,677 37
"	Freight and Express	18 48
"	Seeds, Plants and Sundry Supplies	568 12
"	Tools, Implements and Machinery	887 22
"	Travel Expenses	50
"	Feeding Stuffs	604 71
"	Balance	11 39
		$5,767 79

The above is a true copy from the books of this office.

(Signed) JOSEPH R. OWENS,

Treasurer Maryland Agricultural Experiment Station.

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE BUILDING FUND.

1907.

Dr.

Jan. 1, To State Donation	$5,368 05

Cr.

1907.	
June 30, By disbursement for erecting the Station Barn	$2,814 47
1908.	
June 30, By disbursement for erecting the Station Barn	2,552 45
By balance	1 13
	$5,368 05

The above is a true copy from the books of this office.

(Signed) JOSEPH R. OWENS,

Treasurer Maryland Agricultural Experiment Station.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 119. JULY, 1907

GREENHOUSE PESTS OF MARYLAND.

By A. B. GAHAN.

The production of cut flowers and vegetables under glass is a most important branch of horticulture in Maryland. The United States census report for 1900 shows the total area under glass in this State at that time to be 1,195,000 square feet, and the total value of the products from this area is given as $354,000. In the seven years since that time the industry has developed rapidly, many additions having been made to old plants, and some new ones established, so that the area now devoted to this branch of horticulture will doubtless approximate 1,500,000 square feet, with a corresponding increase in the value of the output.

Of necessity, the production of flowers and vegetables under glass is an expensive process, involving not only a large outlay of capital in the first place, but a continual expense for labor, fuel, water, fertilizers, etc. Consequently, anything which interferes with the fullest and best development of the plants reduces the profits in just that much. One of the most serious drawbacks to the successful commercial culture of greenhouse plants is to be found in the numerous insect pests which have to be combatted.

A greenhouse affords an almost ideal environment for the development and rapid multiplication of certain kinds of insects, and, as a consequence, we find a long list of these pests taking advantage of the opportunity offered, and often doing great damage to many of the principal crops grown in houses. The florists and gardeners are compelled to wage a continual warfare against them in order to avoid serious loss. This necessitates a considerable expense, and in some cases is only partially successful in lessening the damage. Hundreds of dollars are expended every year for expensive insecticides, which at best only afford temporary relief.

Considerable has been written upon the subject of greenhouse pests in various periodicals and other publications, but this material is for the most part in such scattered form as not to be readily accessible to the growers. Most of the insect pests have been described at different times, and considerable material has been published regarding the economic treatment of them. In many cases the life histories of these insects have been but poorly understood, owing to the fact that the different stages in their life cycles are so merged together, and the different generations so poorly defined, that it is extremely difficult to determine them accurately. In this bulletin the author has endeavored to bring together what is known of the life histories and economic treatment of the species occurring in Maryland greenhouses, supplementing this with some personal observations and experiments. Notes were taken, and studies made, of the life histories of several of the species, but in the case of others it was found impossible to obtain specimens that could be isolated and studied.

The list of pests herein treated includes only those that have actually been found by the writer, but it is believed that all of the more important ones common to Maryland greenhouses are covered. The treatment for so many of these pests must, of necessity, be the same, that in order to avoid needless repetition it was deemed advisable to take up the subject of remedies as a distinct subject, rather than to treat the remedies for each individual species of insect separately. In the latter part of this bulletin, therefore, will be found a more or less full discussion of greenhouse insecticides, under the head of "Remedies for Greenhouse Pests."

MEALY BUGS.

Mealy bugs are probably the most universally distributed and well-known of all greenhouse pests. No florist, and but few housewives, attempting to maintain a window garden, but are familiar with them, to a greater or less degree. Two species occur in Maryland, but the commoner one is Pseudococcus citri, Risso. Pseudococcus longispinus, Targ. is not infrequently met with on both indoor and outdoor plants, but is not as conspicuous a pest as is P. citri.

Pseudococcus citri, Risso.

This mealy bug, in the adult form, is about 4mm. in length and 2mm. in width, oval or elliptical in outline, with a fringe of short spines encircling the body. These spines are thirty-four in number, and of about equal length, those on the anal end of the body being slightly longer than the others. The body is covered with a white waxy mass, giving the insect its common name of *mealy bug*. If this wax is removed the body is seen to be of a brownish color.

The female lays from 300 to 500 eggs, depositing them in a mass beneath the tip of the abdomen, and covering them with cottony wax filaments. As the mass of eggs increases in size, owing to the deposition of more eggs, twenty to thirty being deposited every twenty-four hours, the body of the female is gradually tipped upward, until it finally assumes a position almost perpendicular to the surface of the leaf or twig. Egg depositing continues for from a week to ten days, and when it is finished nothing is left of the insect except a shrunken and dried-up skin. The eggs hatch in about two weeks from time of deposition, those first laid hatching first, so that there is a dif-

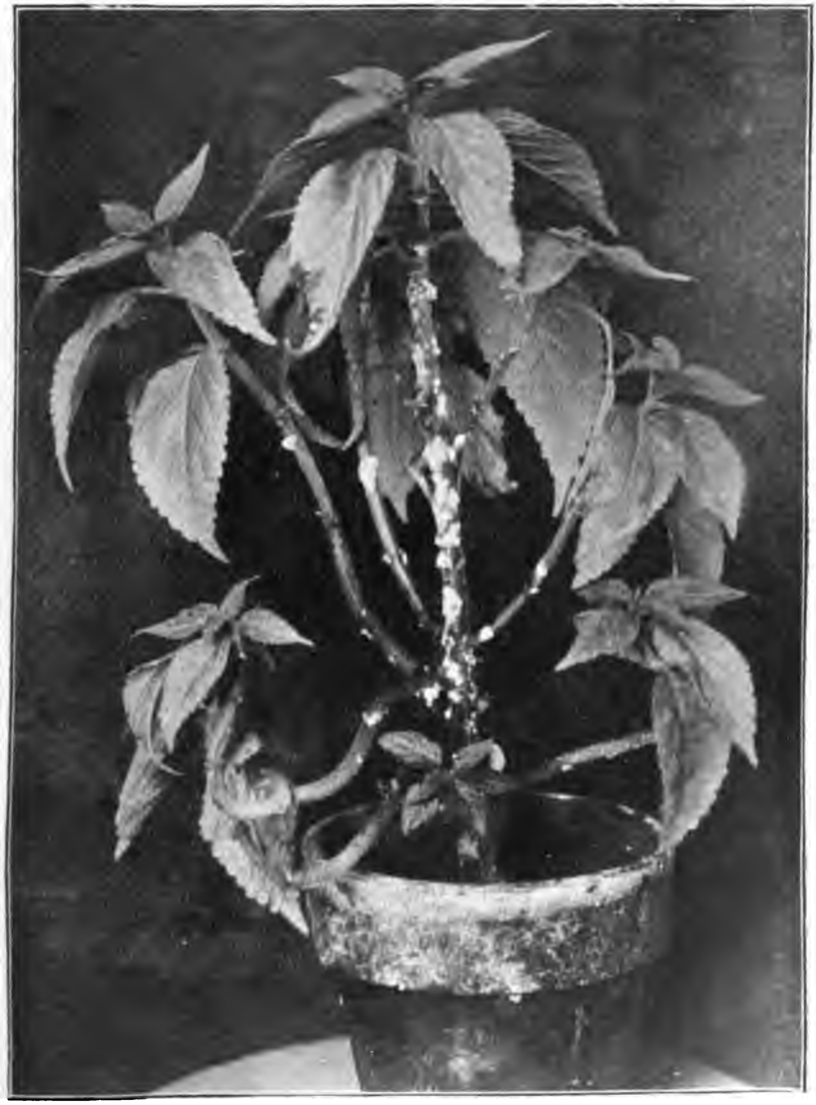

Plate 1—Coleus plant, showing egg-masses and adults of the mealy-bug (*Pseudococcus citri*).

ference of several days in the ages of the larvæ from the same batch of eggs. The larvæ resemble the adults in appearance, except that, when first hatched, they are quite small, and not covered with the white, waxy filaments. They remain in the mass of waxy secretion with which the egg mass was covered for several days before crawling out upon the plant to begin feeding. Owing to the difference in time of hatching of the eggs, considerable difference is noticed in the size of the larvæ from the same batch of eggs, and it is usually possible to find insects of all sizes and ages upon the plant at any time. Their development is rather slow, it requiring about six weeks to two months for them to reach the adult. Most of this time is spent on the underside of the leaves, sucking the juices from the plant by means of a slender sucking tube, which is inserted into the tissue along the midrib and veins.

A few weeks after the eggs have hatched small masses of the filamentous matter will be noticed on the under side of the leaves, usually a short distance from the veins of the leaf. These are the pupæ of the males. The males are small, winged insects, very slow and awkward in their flight, and not readily observed, because of their color, which is a kind of olive brown. They appear and mate with the females when the latter are about half grown.

Pseudococcus citri is distributed over the greater part of the globe, and is one of the most general feeders of all insects, it infesting and damaging a good many outdoor plants in the warmer latitudes, as well as a long list of greenhouse plants. Of greenhouse plants, the coleus, geranium and sago palm seem to be its favorite food plants, but it is often found on many others.

Pseudococcus longispinus, Targ.

This species of mealy bug, as has been said, while quite common in Maryland greenhouses, does not seem to be as abundant as P. citri. It is readily distinguished from that species by the length of the spines at the anal extremity of the body, the last two of which are as long as, and sometimes longer, than the body. In its life history and habits it is so nearly identical with the foregoing species as to render unnecessary any separate treatment, while its food plants are fully as numerous, and many of them the same.

OLEANDER SCALE.

Aspidiotus hederae, Vall.

This scale is one of the commonest found upon greenhouse plants, and is distributed over most of the world. For some reason entomologists have been very greatly confused on this species, it having been described by different persons under no less than thirty different names.

The female scale is circular, nearly white, very slightly convex, and has a pale orange-colored exuvia in the center, or slightly to one

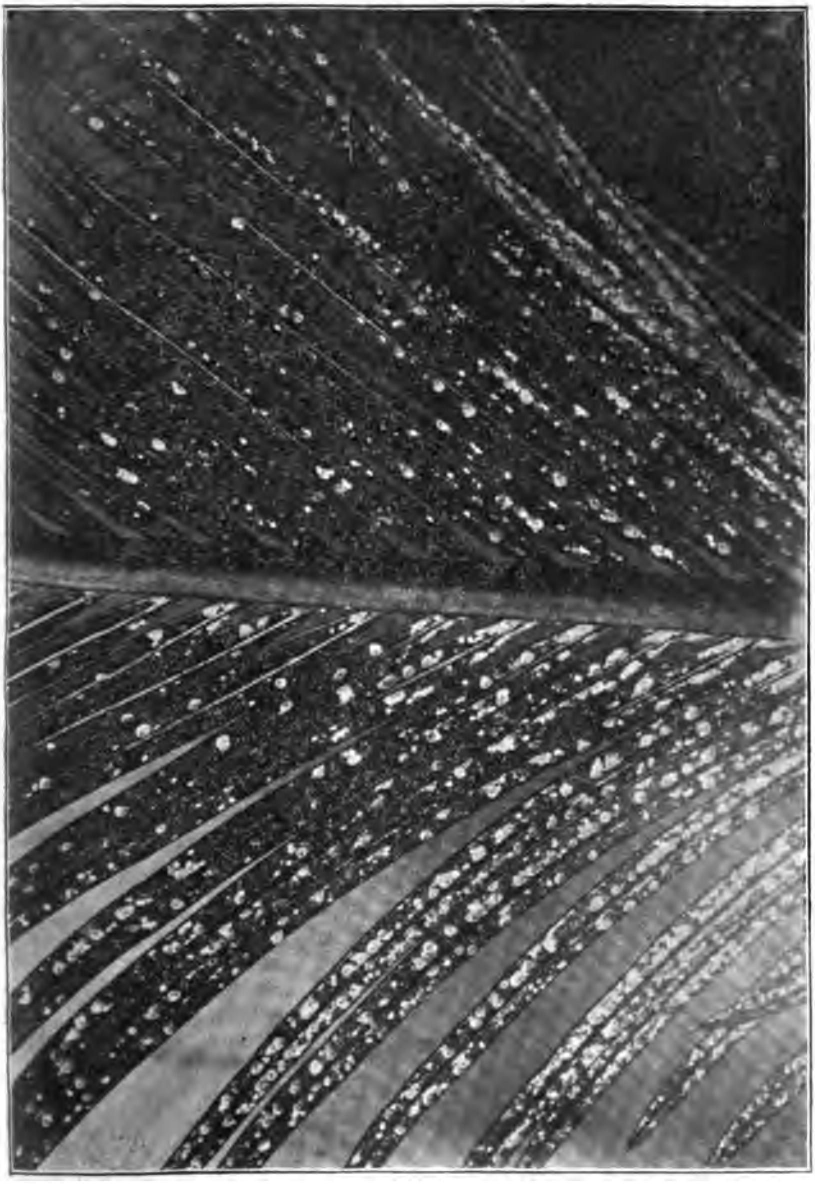

Plate 2—Leaf of Sago Palm, showing bad infestation with Oleander scale (*Aspidiotus hederae*).

side. The first cast skin usually shows the segmentation of the body. The second is more or less covered with a waxy secretion, and appears as a ring around the first. The body of the female is light yellow. The male scale is white, slightly elongate, and has a central exuvia of light yellow.

The eggs of the oleander scale are light yellow, and quite large. They are deposited beneath the female scale, and hatch in a few hours, the young settling either on the leaves or stems. From egg to adult in this species requires between 70 and 80 days, so that in a conservatory several generations are produced in a year. The generations, however, run into each other so that specimens of all stages may be secured from an infested plant at the same time. The young scales seem to prefer to remain near the parent, and consequently they will often be found in clusters, giving to the bark or leaf the appearance of being covered with a thin white film.

A wide range of plants are attacked by A. hederae, both in the greenhouse and outside. Cycads, palms, citrus trees, orchids, and cyclamens are most often found infested.

A CYCLAMEN AND LANTANA SCALE.

Asp. Lataniae, Signi.

Aspidiotus lataniae is a foreign species, probably introduced into America on imported plants. So far as is known, it is purely a greenhouse species in this country.

The female scale is somewhat elongate, quite convex, with the cast skin or exuvia a little to one side of the center, and of a bright yellow color. The remainder of the scale is dirty grayish, with a faint yellowish tinge, due to the fact that the yellow body of the insect underneath shows through the thin waxy scale. The scale of the male is similar to that of the female, but smaller.

The scales are almost always thickly crowded together, rather than isolated, and are not likely to be very conspicuous, as their color usually agrees quite closely with that of the host plants. The color seems even to vary somewhat with the host, specimens found on cyclamen bulbs being considerably darker than those found on palms. The species confines its attacks almost entirely to the twigs and trunks, rarely ever being found on the leaves. Upon palms it is more frequently than otherwise found beneath the remains of former foliage leaves around the stem. Not infrequently a plant will be quite badly infested beneath these fragments of the old leaves without showing on the surface.

The young of Asp. lantaniae come into the world as small living scales, instead of eggs, and fix themselves in close proximity to the mother scale. There is no well-defined distinction between broods, scales of all sizes being found upon the same plants, but it is probable that three or four generations are produced in a greenhouse each year.

Aspidiotus lataniae is known to attack Cycas revoluta, Laurus, palms, citrus trees, cyclamen, Lantana and Areca lutescens. Probably other plants also act as hosts, but the above list includes those most liable to attack.

THE GREEDY SCALE.

Aspidiotus rapax, Comst.

The greedy scale is so called because of the large number of plants which it infests, but as it is a semi-tropical insect it attacks only a few plants grown in greenhouses in the latitude of Maryland. The author found it in one house only, where it was infesting specimens of Laurus.

The female scale is very convex, of a grayish white color, or sometimes tinged with yellow, by reason of the body of the insect showing through the more or less translucent scale covering. The exuvia is a little to one side of the center, and consists of a dark, almost black spot, and a concentric ring of white. A well-developed and pure white ventral scale is present.

This species reproduces by eggs, the same being laid beneath the scale of the female. The young settle upon the trunk and branches of the host plant, and will usually be found grouped closely together, rather than as isolated individuals. So far as could be ascertained from the literature on the subject, the life history of this species has never been thoroughly worked out, and unfortunately it was impossible to secure specimens with which its life cycle could be studied. The generations are very poorly defined, as shown by the occurrence of individuals of all ages upon the host plant at the same time. This fact indicates that breeding is almost continuous, i. e., that the females of one generation continue the production of young up to the time that the first hatched individuals of the new generation reach maturity. No doubt in greenhouses the species produces at least three or four generations in a year, and possibly more.

The following plants are liable to attack by this scale: Laurus, orange, lemon, Fuchsia, Camellia, fig, etc.

THE CIRCULAR SCALE.

Chrysomphalus Aonidum, Linn.

Of all the species of scale found in greenhouses, this one is probably the commonest and the best known. It is world-wide in its distribution, and in semi-tropical regions is a serious pest of outdoor plants, but throughout the greater part of the United States it occurs only on plants growing under glass.

The scale of a mature female is comparatively large-sized, almost circular, quite convex, and with a nipple-like prominence in the center, which is grayish, and surrounded by a reddish brown ring. With the exception of this small central portion the scale is very nearly black, fading out to grayish toward the margins. The scale of the male is smaller, of the same color as the female, but slightly elongate, the posterior margin being extended into a kind of flap, which is distinctly grayish, and embraces about one-third of the circumference of the scale.

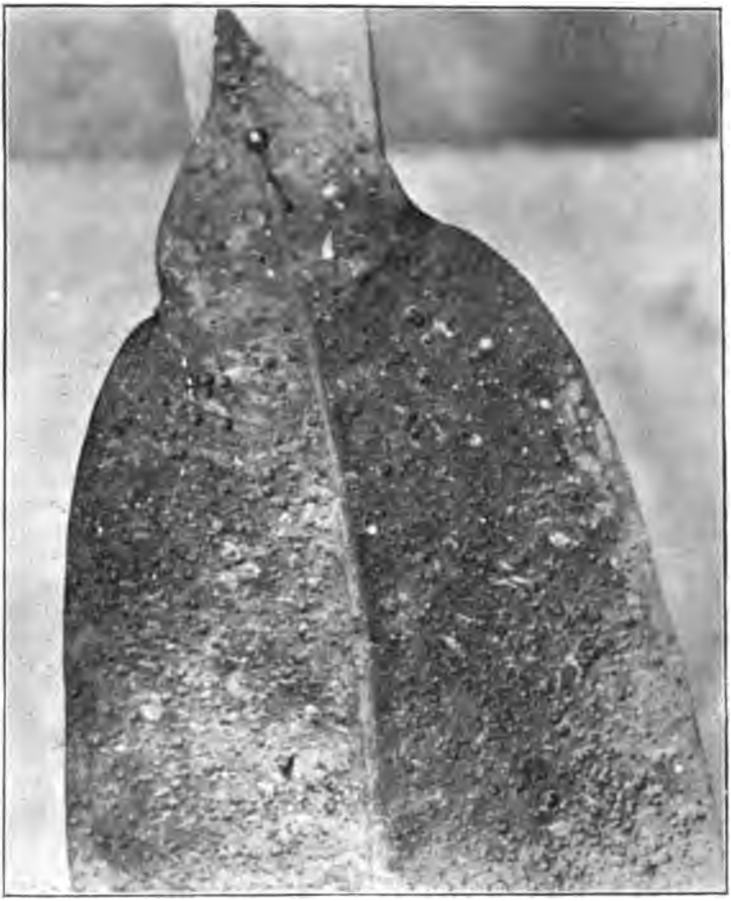

Figure 3—Leaf of Ficus elasticus, showing very bad infestation with the Circular Scale (*Chrysomphalus aonidum*).

The individuals of this species are almost always isolated, and this, with their dark color, makes them quite conspicuous. They occur only on the leaves, infesting both the upper and lower sides. A rather remarkable feature of this scale insect is that, unlike nearly all of the other armored scales, it does not remain fixed after it begins to secrete its scale covering. The young scales hatch from eggs deposited under the scale covering of the female, and, after crawling a short distance away from the mother, insert their beaks, and begin to secrete a scale covering, which is at first white, but gradually becomes darker as the insect increases in age. After a time the young insect apparently exhausts the supply of food at that place, and then it moves a short distance forward to new pastures. During the life of an insect it probably changes its position several times, although the aggregate distance traveled is rarely more than one inch. A yellow or dead streak in the surface of the leaf is left behind as the insect moves forward, showing where the sap has been exhausted, and the tissue killed.

About six generations of this species may occur under greenhouse conditions in a period of a year, the life cycle being completed in from sixty to seventy days. The female continues oviposition for about twenty days, and in that time produces in the neighborhood of two hundred eggs.

Chrysomphalus aonidum attacks principally those ornamental plants having fleshy leaves, for example: Palms, Cycads, Ficus, citrus plants, oleander, etc.

THE CHAFF SCALE.

Parlatoria pergandii, Comst.

This scale was first described by Professor Comstock, in the United States Department of Agriculture Year-book of 1880, as occurring in Florida upon citrus trees. It is now quite commonly found infesting this class of plants growing under glass. The scale of the female is a dirty gray in color, usually slightly longer than broad, with the cast skin or exuvia at one end. The first cast skin is small and bare, the second considerably longer, covering about a third of the length of the scale, and has a covering of waxy secretion. The male scale is long and narrow, with the lateral margins nearly straight and quite prominent. The exuvia is at the anterior end, quite large and somewhat darker colored than the remainder of the scale, which is light grayish. The larvæ are purplish in color, as are also the eggs, which are deposited beneath the female scale, where they hatch in a very short time.

Apparently the females of this species are not as prolific as those of some others. However, the life cycle is short, covering from six weeks to two months, and, consequently, the scale increases quite rapidly during a season. The young settle upon the trunk and branches mainly, though sometimes they may be found on the leaves. Owing to close resemblance in color to the bark of orange and lemon, the scale is easily overlooked, and may cause considerable injury before noticed. It is not, however, a very destructive species.

So far as known its work is confined to the citrus trees entirely.

THE EUONYMUS SCALE.

Chionaspis euonymi, Comst.

This species is not of any great importance to the greenhouse florist, inasmuch as its favorite food plants (the different species of Euonymus) are not extensively grown under glass. It was found by the writer in a greenhouse near Baltimore, badly infesting several specimens of Euonymus japonica growing in pots, and used for decorative purposes, however, and is included here for that reason.

The female scale is very narrow, almost pointed at the anterior end, and beginning at about a sixth of its length from the front widens rapidly posteriorly, frequently attaining a width near the rounded posterior equal to its length. The scale is firmer in texture than is usual in the genus, quite convex, and dark grayish brown in color. The ventral scale is complete, but unattached posteriorly. The scale of the male is long and narrow, with parallel sides, and three ridges or carinae running lengthwise, and a yellow exuvia at the anterior end. The eggs of this insect are laid beneath the mother scale, are of a purplish color, and very numerous. Under outdoor conditions they hatch about May 15 to the first of June, and probably produce two generations in a season. Under greenhouse conditions, however, it is possible that a third generation may occur.

The writer has never found the species upon anything except Euonymus, but it is said to infest lemon, orange and althea. It is a serious pest of Euonymus, often killing the branches, and sometimes the whole plant, in a single season.

THE ZAMIA SCALE.

Aulacaspis zamiae, Morg.

Aulacaspis zamiae has only twice been recorded as occurring in America—once by Dr. Felt, of New York, and once by King, of Massachusetts. In each instance it was greenhouse plants that were infested. The insect is undoubtedly an imported species, probably being brought in on Cycads from Bermuda. It has only come to the writer's notice in one instance, that being on a specimen of Cycas revoluta, which was in storage in a greenhouse in Baltimore.

The scale is circular, very convex, pure white in color, and frequently has the sides fluted or corrugated. The exuvia is lateral, elliptical in shape, the first larval skin being within the marginal limits of the second, and placed anteriorily. The scale covering is quite tough and leathery, much more so than is commonly the case with the armored scales. The ventral scale is well developed.

The insects were all found on the underside of the small leaflets of Cycas revoluta, and generally in isolation, rather than grouped. In this habit the species differs markedly from Aulacaspis rosae, which it otherwise resembles. The pure white color, marked convexity, and the above-mentioned habit of isolation make the species quite easy to distinguish from any other likely to be found infesting greenhouse plants.

Only three plants have yet been named as hosts for the species, viz., Zamia villosa, Zamia integrifolia and Cycas revoluta.

THE BLACK SCALE.

Saissetia oleae, Bern.

This is another very widely distributed scale, being found in nearly all parts of the world. In the warmer climates it infests outdoor plants, but in our latitude, and throughout most of the United

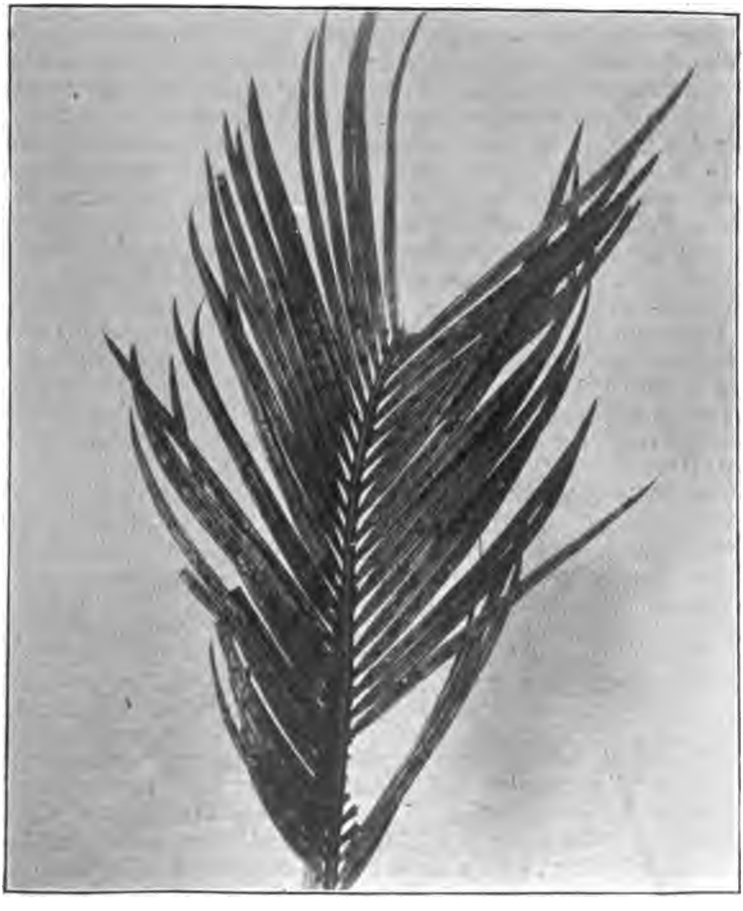

Figure 4—Palm leaf infested with Black scale (*Saissetia oleae*).

States, it occurs only as a greenhouse pest. It is not particularly destructive, but often occurs in great numbers, and always accompanied by a black fungus, which lives upon the honey dew excreted by the insects, thus rendering the attacked plant very unsightly in appearance.

The scale is quite large, slightly longer than wide, and quite convex, with a prominent ridge or carina down the middle of the dorsum, and two transverse ridges, the three ridges forming a rough imitation of the letter "H." The sides of the scale are quite flaring, and more or less corrugated. Altogether, the dorsum presents a very rough appearance. In color this scale is very dark brown to almost black.

The females of this species seem to be more than ordinarily prolific, even for scale insects. Dr. Coquillet reports having counted as high as 2,200 eggs and young larvæ from a single female. It is probable, however, the average number will be somewhat less than this, as out of a dozen specimens examined by the writer, in no case were over 1,200 eggs found, and usually less than that. The first eggs begin hatching, however, sometime before ovipositing is finished, and therefore it is possible for a considerable error to be made in estimating the number of eggs actually produced. The young, after hatching, remain for a short time beneath the mother scale, and then crawl out and begin feeding. Unlike most other coccids, this species never, or at least not until quite late in life, loses the power of locomotion, but is able to change its location at will. They feed either upon the leaves or stems; palm leaves have been observed almost completely covered with them, and the dirty black fungus which accompanies them. Happily, the life cycle of this insect is a long one, one generation requiring almost a year to complete its cycle. The egg-laying period for a single female stretches over several months, and the hatching of her eggs covers a like period, so that one will find crawling larvæ upon the plants at almost any time. For this reason it is extremely difficult to obtain accurate data in regard to the exact length of any period of the insect's life.

The black scale is by no means as general a feeder in the greenhouse as some of those previously mentioned. It confines its attacks principally to the citrus trees and palms, but may, at times, be found infesting rose, oleander, Ficus, Euonymus, Cycas revoluta, and possibly others.

THE HEMISPHERICAL SCALE.

Sassetia hemispherica, Targ.

This scale is one of the commonest found upon greenhouse plants. It takes both its popular and scientific name from its shape, which more nearly approaches that of a hemisphere than any other scale. The outline of the body is slightly elliptical, i. e., somewhat longer than broad, varying to some extent with its position. Upon the twigs or stem it is apt to be more elongate, with the edges flattened and bent to conform to the shape of the twigs. The back is very convex, smooth or slightly wrinkled, and shining. The color varies from a light brown to a dark brown, and often nearly red.

This species is oviparous, the eggs being deposited beneath the body of the female. The under side of the female gradually shrinks as the eggs are deposited, until, when oviposition is finished, and the female dies, nothing remains but the hard outer shell, which is almost completely filled with eggs. The young, upon hatching, go to the leaves and settle there along the mid-ribs and veins, where they remain for a period of four to six weeks, when they migrate back to the stems, and there settle permanently. Under greenhouse conditions the life cycle in this species is completed in five to six months, allowing the development of two complete generations in a year. A single female may produce from five hundred to a thousand eggs, most of which hatch, but of course only a small proportion of the young establish themselves successfully upon the plants. Unlike some species of this genus, the eggs from a single female all hatch at about the same time.

The food plants of this species are almost as numerous as those of Coccus hesperidum, and hemispherica is fully as troublesome as is that species. Its favorite host plants are ferns and crotons, but it also attacks chrysanthemums, orange, palms, orchids, camellia, guava, salvia, rose, oleander, abutilon, Cycas revoluta, alternanthera, and probably other greenhouse plants.

THE SOFT SCALE.

Coccus hesperidum, Linn.

This scale gets its popular name of the soft scale from the fact that its shell is soft and easily crushed. It is one of the most widely distributed of scales, being found practically all over the world. The young are small, elliptical and flat, almost colorless creatures, hardly distinguishable from the leaves upon which they are found. The color changes gradually with age. The adult scale is dark brown, or almost black, somewhat longer than wide, quite convex, and with a prominent ridge running lengthwise down the middle, and two transverse ridges running nearly to the margins. The margin of the scale is somewhat flattened, and marked with many small transverse ridges running to the edges, and usually it has two more or less well-defined notches on each side, opposite the ends of the large transverse ridges, and a less conspicuous one at the rear end. The scales are usually accompanied by the black fungus growth, common to this and related genera, and which grows upon the honey dew secreted by them, giving to the surface of the infested leaves a dirty and unsightly appearance. Certain ants are very fond of this honey dew, and not infrequently infested plants will be found with little groups of ants gathered about individual scales, enjoying the dainty feast. Where ants are plentiful the fungus is generally absent. Whether the ants in any way protect or spread the scale I do not know.

The insect is viviparous (i. e., the egg stage is lacking). The young usually remain under the body of the female for several days, then crawl out upon the leaf, and establish themselves along the mid-rib or veins, or sometimes on the young growth of the stem. In greenhouses, breeding is continuous, several generations being produced in a year. A female produces young during a considerable period, scales of all sizes and ages being found on the plants at the same time.

The food plants are numerous, embracing nearly all types. Begonias, crotons, palms, Ficus, cyclamens, anthuriums, all citrus plants, Euonymus, roses and calla lilies constitute a partial list.

THE LONG SCALE.

Coccus longulus, Doug.

Coccus longulus is a very widely distributed scale, being found in many parts of the world besides America. It infests both outdoor and indoor plants in warm climates, but is confined to hot-houses and conservatories farther north.

The scale is about twice as long as broad, rather flat, rounded at both ends, and with the dorsum perfectly smooth and shining. In color it varies from light brown to very dark brown. The young are nearly colorless at first, of about the same shape as the adult, but small, and provided with legs. They usually fix themselves close to a mid-rib or vein of the leaf, though quite frequently they may be found on the upper sides of the leaves.

The list of food plants is a long one, but not as long as that of Coccus hesperidum. Its attacks on greenhouse plants are usually confined to the Ficus, Euphorbia, citrus trees, Albizzia and ferns.

THE BLACK APHIS OF CHRYSANTHEMUM.

Nectorophora chrysanthemicolens, Will.

The black aphis, or "black fly," as it is erroneously called by most florists, is too well known to warrant a detailed description here. Wherever chrysanthemums are grown it will be found sucking the sap from the stems and leaves. The insects gather about the terminal buds upon the young growth, and, if neglected, soon become so numerous that the growth of the plant is completely stopped. The rate of increase is almost incredible, and has led some growers to believe that the pest is a product of spontaneous generation. Some observations taken by the writer will serve to illustrate the remarkably rapid rate of increase in this species. Young agamic (that is, non-sexual) females isolated upon separate plants, began producing young in every case within eight days after birth. Each female produced from four to sixteen young lice per day, and the average number produced by each

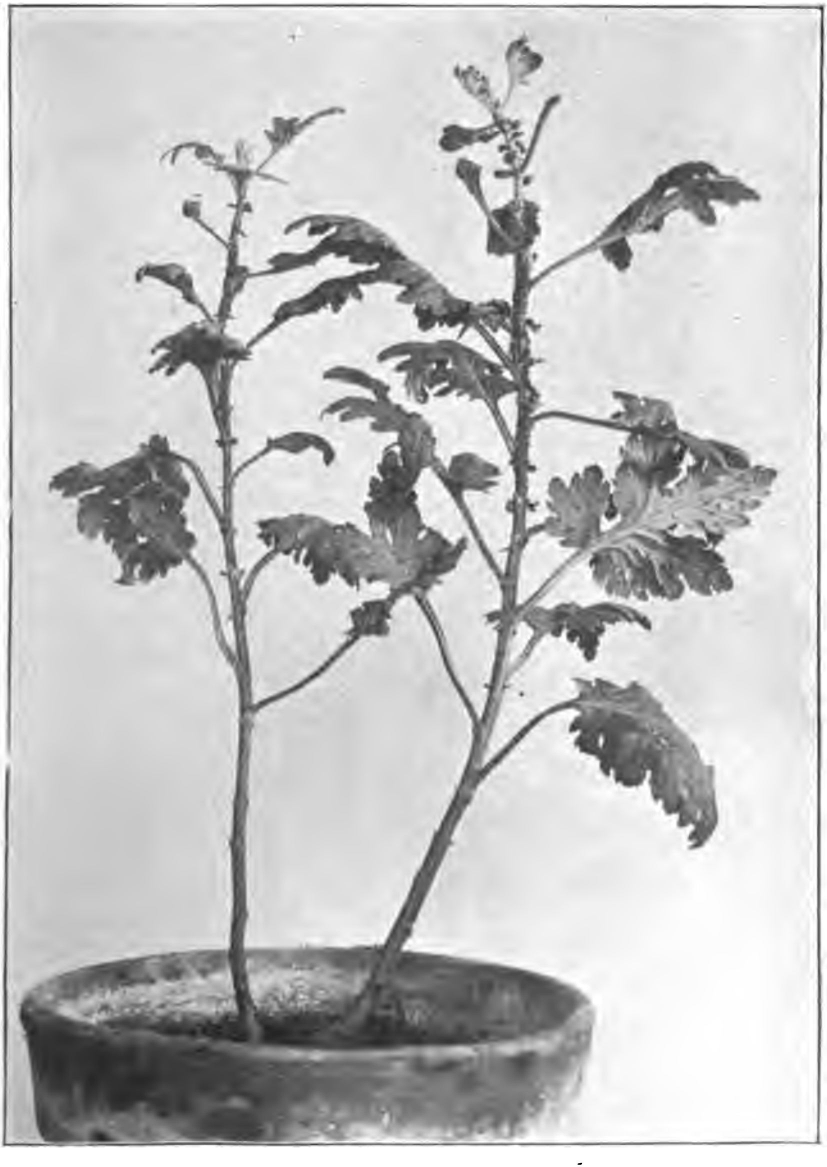

Plate 5—Chrysanthemum infested with black aphis (*Nectorophora chrysanthemicoleus*).

was about two hundred. These young lice all insert their beaks, and begin drawing sap almost immediately after birth, and without wandering far from the mother aphis, unless crowded for room, when they move away to a place where they will not be interfered with, which may be lower down the stem, on the under side of the leaf, or upon a new plant. It can readily be seen from the figures above that the number of lice upon a plant, which has been neglected for two or three weeks, will be something enormous, even with but one female on the plant to start with. Winged females are produced at intervals, and these fly to other plants and bring forth young in the same manner as the wingless form, that is, without the intervention of the egg state. It is not known how long this reproduction of the species agamically can continue under greenhouse conditions, but it is certain that a sexual form of female is produced at intervals which, after mating with the males, produces eggs from which agamic females again appear, and give birth to living young.

So far as known to the writer, N. chrysanthemicolens attacks no other plant than the chrysanthemum. Other species of black aphids occur in conservatories, notably upon the rose and violet, which are often mistaken for this one, but which are distinct species.

THE GREEN APHIS OF THE ROSE.

Nectorophora rosae, Linn.

The green aphis of the rose is one of the greatest drawbacks to successful rose culture in greenhouses. It is found attacking the leaves and young twigs wherever the rose is grown, and occasions the florists considerable expense and labor in its control. The species was originally described from Europe. Some doubt exists as to whether the European species and our own are identical, but most writers who have treated the subject have considered them as the same.

The following description of Nectoropora rosae is taken from Thomas' Eighth Report on the Noxious and Beneficial Insects of Illinois:

"The wingless viviparous female is about one-eighth of an inch long, of an elongate ovate form; shining green or reddish, antennae as long, or longer, than the body; honey-tubes long, reaching beyond the tip of the abdomen; tail prominent, yellow; eyes red, legs long, yellowish green, with black knees and feet. The winged female has the head and thorax shining black; eyes red; antennae longer than the body, dark; abdomen green, with about five black dots on each side in advance of the honey-tubes, and usually two short transverse black bands behind them; tail yellow, hairy; wings large, sub-costal vein yellowish, other veins dark, stigma greenish, honey-tubes black."

The winged form is rarely seen, practically all reproduction being carried on by the viviparous form. Breeding in this form is extremely rapid, one female producing from four to ten young per day, and it requiring but eight days to two weeks for these young to reach maturity. It is surprising how soon plants will become reinfested after a fumigation that apparently killed all but a few scattering individuals.

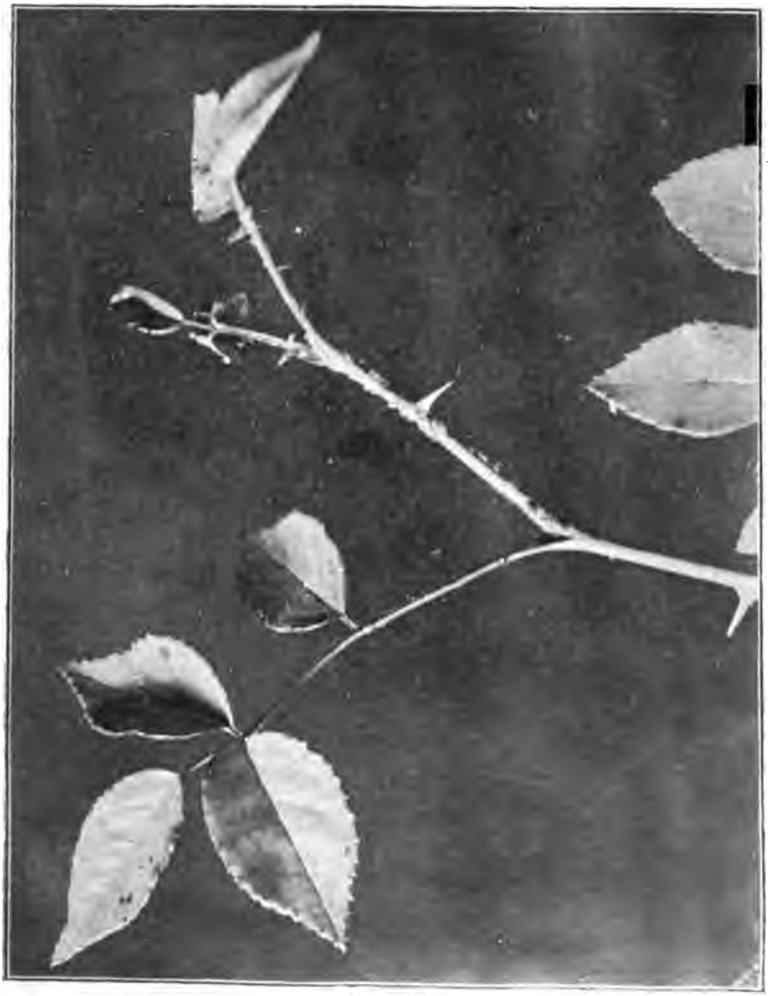

Figure 6—Twig of rose, showing infestation with the Rose aphis (*Nectorophora rosae*).

Three or four weeks suffice to reinfest them almost or quite as bad as before the fumigation. The favorite part of the plant for these aphids to feed upon seems to be the extreme ends of the new growth or the flower buds. They not infrequently become so thick about the buds as almost to cover them, and when this occurs the bud is rendered worthless. In most of the essential points of its life history this species closely resembles the chrysanthemum aphis.

So far as known to the writer its attacks are confined to the rose plant.

THE MELON APHIS.

Aphis gossypii, Glov.

This plant louse is a well-known enemy of outdoor grown plants, especially those belonging to the Cucurbitaceae, and has been mentioned frequently as a pest of greenhouses as well. It is a general feeder, affecting many weeds and garden vegetables, besides the Cucurbits. In greenhouses the writer has found it only upon cucumbers, begonias and an Hibiscus, but it doubtless affects many others also. Like other similar species it is known to florists and gardeners as "green fly," no attempt being made to differentiate between it and other greenish-colored species of Aphididae. The color of the species varies greatly, ranging from almost yellow to nearly black, but the prevailing color noticed by the writer is a more or less purplish green. Like the other aphid pests of greenhouses, this species increases very rapidly, and if neglected soon injures its host. The lice confine themselves principally to the under side of the leaves of the cucumber, but those found upon the begonias and Hibiscus were attacking the flower buds and terminal shoots of the plant, and entirely ignoring the leaves. The life history is practically the same as that of the chrysanthemum aphis, both winged and wingless agamic females being produced, and a generation of sexual individuals developing at intervals. The females possessing wings are much more numerous in this species than for any of the others found in greenhouses.

In addition to the plants already mentioned as hosts for aphis gossypii, Mr. Chittenden, of the United States Department of Agriculture, reports these greenhouse plants as subject to attack: Ground ivy, hydrangea, Acalypha, bean and beet.

THE BROWN APHIS OF THE VIOLET.

Rhopalosiphum violae, Perg.

The brown aphis of the violet, although at present a very widely distributed species, had received but little, if any, attention prior to 1894, when it was first described and named by Mr. Pergande, from specimens collected at Garrett Park, Maryland. The species is sufficiently distinguished from the green aphis affecting the violet by its color, which is dark brown, both in the winged and wingless forms. The winged form is still more easily recognized, because of the dark-clouded venation of the wings. The insects are generally found on the stems of the leaves well down towards the crown, where they are not readily seen, and where they are difficult to reach with any kind of spray. Their injury is rather a stunting of the plant, causing it to produce weakly and imperfect flowers, than the actual killing of it.

In this species, as with other aphids, breeding is so rapid as to seem almost incredible. In no point of its development does it differ materially from the foregoing species. Winged agamic females, which produce agamic young, and enable the species to spread, are developed at intervals, but seemingly without any regularity, appearing to depend more upon circumstances as regards food than upon anything else. When a plant becomes so completely infested as to cause crowding among the insects, the winged females appear, and in this way enable the species to survive. As the wingless individuals are unable to spread to new food plants, to any extent, but must remain upon the plant where born, some such provision as the winged female is necessary. Otherwise the insects would become so numerous upon the original plant as to kill it, and thus the species would exterminate itself. A sexual generation no doubt occurs also, but has not been observed.

The species occurs on no other plant than the violet, so far as known.

WHITE FLY.

(*Aleurodes citri*), Riley and Howard.

This pest is well known to most florists, and is one of the most troublesome insects that they have to contend with.

The insect is a sucking one, belonging to the order Hemiptera, or true bugs. It is very small, being only about one-twentieth of an inch in length and twice that in wing expansion. The wings, which are the most conspicuous part of the body, are pure white, giving to the insect its popular name of white fly. The body is yellow. The larvæ are much smaller, wingless, pale greenish-yellow in color, with two yellowish spots on the upper side of the abdomen, and their eyes, of which there are four, are red. In this stage a white fly somewhat resembles a young mealy bug, except that the margin of the flat body lacks the spines of the Pseudococcus larvæ.

The eggs of the white fly are deposited on the under side of the leaves, and are very minute, yellowish green in color, and attached by means of a slender pedicel or stem. The surface of the egg is smooth and shining. About 20 to 25 eggs are laid by each female, hatching in from ten days to two weeks. After hatching the larvæ, after crawling a short distance, attach themselves to the under side of a leaf, and begin sucking the sap. They remain attached until full grown, when the winged adult emerges, and it also derives its sustenance by sucking the sap from the leaves. The complete life cycle requires a period of about six weeks, and thus it will be seen the insects increase very rapidly.

The presence of the pest is easily detected. Though very small, the adults are quickly seen, owing to their conspicuous white wings. They take flight at the least disturbance of the plant upon which they are feeding, and, if numerous, will sometimes arise in clouds. Badly infested plants wilt down, owing to the loss of sap. Examination of these wilted plants will generally show them covered with a dirty-colored fungous growth, which is induced by the presence on the leaves of a sticky secretion from he young bugs.

A list of food plants would include very many of the principal plants grown under glass. Professor Britton, of Connecticut, reports having found eggs upon 58 different species of plants, some of which were growing out of doors. Its favorite food plants, however, among those grown under glass, seem to be tomatoes and cucumbers. Geraniums, chrysanthemums, heliotrope, rose, primula, lantana, salvia, fuchsia, aster, coleus, bean and lettuce are also subject to attack and severe injury by it.

RED SPIDER.

Tetranychus bimaculatus, Harvey.

Notwithstanding its popular name, this pest is in reality not a spider at all, but a tiny mite belonging to the family Tetranychidae. It was first described and named by Professor Harvey in the annual report of the Maine Agricultural Experiment Station for 1892. Up to that time all the spinning mites (with the single exception of one occurring on oranges) had been indiscriminately referred to as belonging to a single species, Tetranychus telarius, a common species in Europe. In 1900 Mr. Nathan Banks, after careful study, recognized ten distinct species as belonging to the genus Tetranychus (Technical Bulletin, No. 8, United States Division of Entomology). He found T. telarius infesting outdoor plants, but was convinced that the common mite of greenhouses was, as Professor Harvey had said, a different species from the European one, and he retained the name given by Professor Harvey, T. bimaculatus. The error of previous authors in considering all of the spinning mites as belonging to a single species undoubtedly arose, for the most part, from depending merely upon superficial characters for their identification.

For the purposes of this paper it will not be necessary to go into a detailed and technical description of T. bimaculatus, since apparently only the one species is likely to be found on greenhouse plants. In some respects the name red spider is a misnomer, as the mites vary in color from pale pinkish to almost black, depending upon the age and food plants of the individuals. Some specimens are even greenish, with two or more darker spots on the back of the abdomen. They are extremely small, though visible without the aid of a glass, but are likely to be overlooked until attention is called to them by the injury to the plants. Attention is sometimes drawn to them by reason of the thin white web which is spun on the surface of the leaves, but it is usually only in cases of bad infestation that the web becomes apparent. The injury to the leaves is quite characteristic. The leaves of an infested plant first become dotted with brownish patches, usually on the under side, and then gradually wither and dry up.

The eggs of the mite are deposited on the underside of the leaves, from five to ten being laid each day, and one female will lay from 80 to 100 eggs. These hatch in three or four days, under favorable conditions. Observations indicate that in a greenhouse three to four weeks are sufficient for the completion of a life cycle. It will thus be seen that the rate of increase will be something enormous, if the mites are left undisturbed. Fortunately, the ordinary methods of caring for plants under glass destroy large numbers of them, and thus partially hold them in check.

The list of food plants of the red spider is a long one, including many of the common greenhouse plants. The carnation, rose, geranium and violet are especially liable to attack, however, and it not infrequently causes great damage to these plants. Probably the rose and carnation growers are the greatest sufferers, it sometimes occurring that even well-cared-for houses become so badly infested as to render the crops of these flowers almost valueless, owing to the stunted condition of buds which have been robbed of their natural nourishment.

THRIPS.

Carnations are not infrequently badly damaged by tiny insects called thrips, which are closely related to the true bugs, or Hemiptera. The thrips work in the flower buds, causing small, irregular white blotches to appear on the petals, and thus rendering them imperfect. In case of bad infestation, the flowers are rendered unsalable, and the florist sustains a heavy loss. The blotches are caused by the sucking of the sap from the petals before the flower is open, causing the tissue to turn white.

The insects are less than a tenth of an inch long, very slender, and in the adult form dark colored, almost black, with four small membranous wings carried flat on the back. The head is quite small, and the abdomen long and slender, giving the insect the appearance of being pointed at both ends. The larvæ are slightly lighter in color than the adults, and have no wings, but otherwise they look much alike. When disturbed the thrips will frequently elevate the tip of the abdomen, as if intending to sting. They are very active, leaping or flying readily, or wriggling out of sight so quickly among the bases of the petals when the flower is torn open that it is very difficult to capture one of them. The life history of the greenhouse species has never been satisfactorily worked out, but it is probable that the eggs are laid in the tissue of the plant in the leaf or stem, as with other species of the genus, and when the eggs hatch the young larvæ crawl out and feed by sucking the sap, as do the adults.

The carnation is the only greenhouse plant liable to be severely injured.

WIREWORMS.

Considerable damage is sometimes done to greenhouse plants by larvæ of certain click-beetles known as wireworms, which feed upon the roots. These larvæ are long, slender, dark-brown creatures, slightly resembling centipedes in appearance, but having only six legs and a head that closely resembles that of the adult beetles. The beetles are dark brown or black, long and slender, and when held in the hand endeavor to jerk themselves loose by snapping their heads violently up and down. The adults are seldom seen about the houses, the larvæ being much more commonly observed.

The larvæ apparently have no favorite food plant, but infest all about alike, their presence seeming to depend somewhat upon the character of the soil in which the plants are grown.

SOW-BUGS.

A rather severe injury to orchids by sow-bugs was observed by the writer recently in a Baltimore florist's establishment. This is another greenhouse pest that cannot be classed as an insect, although the appellation of sow-bug would seem to indicate that it belonged to that class. Its structure, however, places it naturally in a class with the snails, crabs, crawfishes, etc., and it is consequently classed as a crustacean.

The pests are dark gray, oval, flat-bodied creatures, with the body distinctly divided into segments. Seven pairs of legs are borne upon the thorax, one pair to each segment. The abdomen, which is plainly separated from the thorax, bears a pair of inconspicuous rudimentary legs upon each segment, and at the tip are two long, flattened appendages. The sow-bugs are quite active, quickly dodging under the nearest protecting object when exposed to the light.

They are not ordinarily considered as injurious, being more commonly observed in cellars, under decaying wood, or in other damp and secluded situations. The perforated pots, filled with broken pieces of pottery or stones, in which the orchids are grown, furnish an ideal hiding place for them, and the large, fleshy roots of the plants constitute an apparently acceptable diet. The feeding is done at night, the terminals or growing points of the roots being eaten off, and the growth of the plants restricted.

No instance of injury to other plants than orchids has ever come under the writer's notice, and it is probable that their work upon these plants is largely due to the circumstance that the loosely filled pots furnish such an inviting habitation.

SLUGS.

One of the most annoying pests of the florist is the slimy, repulsive-looking creature commonly referred to by the grower as a snail. The creature is not, however, a snail, but is properly called a slug. Several species are found infesting greenhouses, but the commonest one is probably Limax maximus.

These slugs vary in length from a half inch to three or four inches when adult, are dark colored, sometimes nearly black, often spotted or striped above, and the body is covered with a slimy mucous secretion, which sticks to whatever the slug crawls over, leaving a trail of glistening slime to mark its path. The head and body are contractile, and upon the head are two contractile feelers, which are

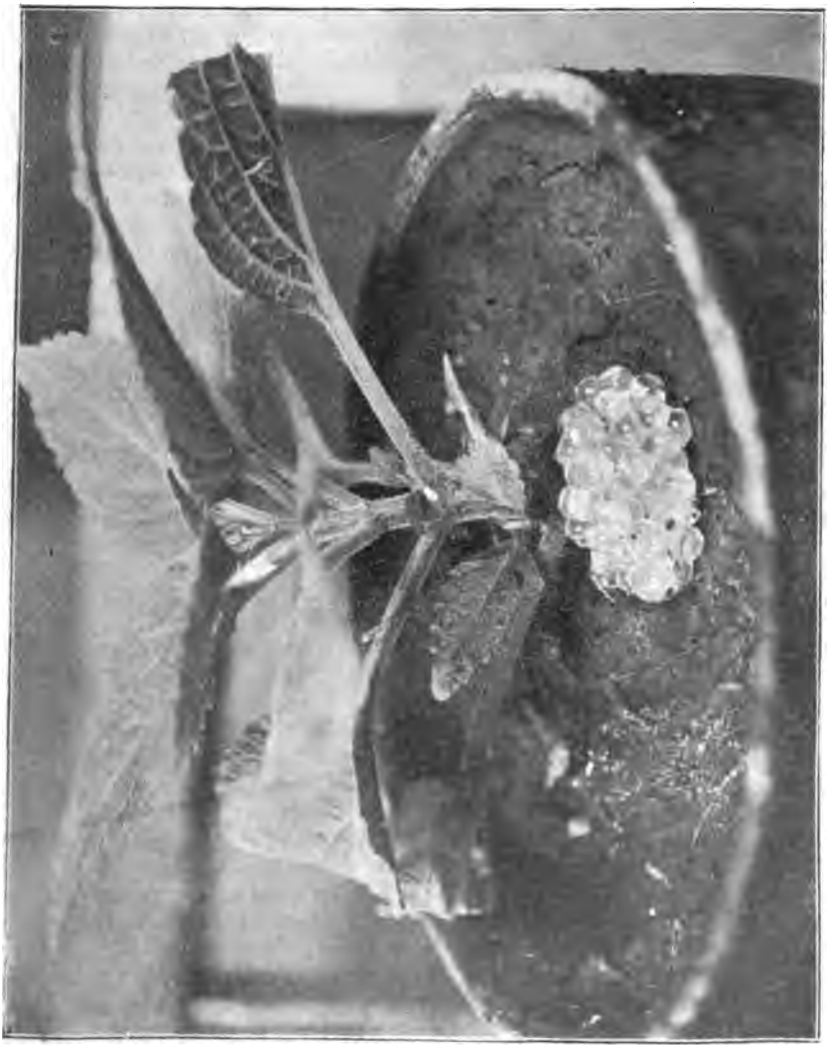

Figure 7—Eggs of the greenhouse slug (*Limax maximus*). About natural size.

being continually thrust out and drawn in when the slug is in motion. Just back of the head is a broad plate, or mantle, slightly different in structure from the rest of the body. An opening in the margin of this mantle on the right side marks the opening of the respiratory organ.

Little is known of the life history of the pest. The author was lucky enough to secure from a female confined in a breeding jar a batch of eggs, a photograph of which is here shown, but unfortunately was unable to obtain any young from them. The eggs had probably not been fertilized. They were about the size of an ordinary garden pea, semi-transparent, and there were about sixty or seventy of them in the batch. They were all deposited in a compact mass, and were held together by a transparent mucous covering, which enveloped each egg. When the adult slugs are irritated, the flow of the mucous secretion is greatly increased, and this has suggested one method of destroying them. If tobacco dust, air-slaked lime, ashes or soot be sprinkled liberally about the benches among the pots where the slugs will be compelled to crawl through it to get at the plants, the fine particles will be caught up by the mucous covering, and will cause an irritation that will increase the secretion, and as this dries quickly upon exposure to the air, the slug will soon exhaust itself, and become a prisoner, and will eventually die.

Many different kinds of plants are injured by these slugs, they seemingly having no favorite food plants.

REMEDIES FOR GREENHOUSE PESTS.

The handling of the insect pests of greenhouses presents several features not met with in any other phase of insect control. In the first place, most greenhouses contain not one or two kinds of plants only, but a great many different kinds, varying widely in their characteristics, and incapable of withstanding the same modes of treatment. For instance, a house given over entirely to violet culture may be safely fumigated with a strong charge of potassium cyanide, whereas, if a house containing, besides violets, a number of other species of plants, be treated with the same charge, the results would be disastrous. Therefore, some other treatment for the violets in the latter house becomes necessary.

Again, the manner of growing plants in a greenhouse may render impracticable or difficult certain modes of treatment that would be all right outside. In order to economize space, the plants are grown as close together as possible, and often upon benches that can be approached from only one side. Spraying or syringing under such circumstances is likely to be ineffective, owing to the fact that the insects cannot all be reached by the spray. An added disadvantage in spraying or dusting with insecticides in greenhouses is the difficulty of getting about between the benches with any sort of adequate apparatus. A bucket pump or a knapsack sprayer are both unsatisfactory, but about the only instruments available.

The great prolificacy of many of the species, and the fact that breeding goes on the year round with many of them, renders imperative some effort at their control. The purposes of the author will be to put before the florists the best methods of handling the various pests in so far as he has been able to determine the best methods through consultation with experienced greenhouse men, perusal of literature upon the subject, and personal observations and experiments performed with that object in view.

The general subject of insect control in greenhouses may be divided into distinct heads, as follows: Precautionary measures to prevent infestation, syringing with water, fumigation, dipping, spraying and dusting. Under each head will be discussed the different methods and materials used, as well as mention of the pests to which each treatment applies.

PRECAUTIONARY MEASURES TO PREVENT INFESTATION.

Since a greenhouse is closed, and practically isolated from all outside influences, insects as well as others, it seems apparent that infestation with insects must come about in one of two ways, either by the pests being carried into the house on plants, or cuttings, or by their being harbored in the house already from some former crop of their food plants. Both of these conditions are known to exist, and it is probable that infestation is seldom brought about in any other way. This suggests the thought that if the house can in some way be completely rid of insects, and then no plants be taken into it except what are known to be free, much of the trouble of fighting insect pests should be done away with.

There are very few houses, we believe, that are not at least once a year completely cleared of all plants, and many receive such a clearing out between crops more than once. It is the writer's belief that if the growers would take advantage of these opportunities, and fumigate their houses for several hours with a strong charge of potassium cyanide, that they would find their houses much freer of insects for some time to come than is ordinarily the case. Many of the pests, such as red spider, white fly, aphids, slugs, etc., pass the period between crops of their food plants, either upon weeds that may be growing about the place, or concealed in cracks and other hiding places. A thorough fumigation with twenty-hundredths of a gram to a cubic foot, or at the rate of seven ounces of cyanide per one thousand cubic feet of space in the house, would guarantee the destruction of all insect life in it, and leave the house practically clean for the new crop. This treatment would be comparatively inexpensive, and but little trouble. An instance may be cited of a tomato house that was swarming with white fly. The crop having been harvested, the house was thoroughly fumigated in the spring of 1906, just before the vines were removed. The floor of the house was literally covered with dead flies after the treatment. Another crop of tomatoes was started in the house in the fall of the same year, and in March, 1907, not a white fly had as yet appeared in it, although another tomato house a few yards away was swarming with the pests at that time. In the writer's opinion, although he has not as yet tried it, the carnation houses would be greatly benefited by similar treatment for the red spider. It is understood, of course, that such a strength of cyanide is not to be used in a house where there are growing plants, but only when the crop has been harvested, and the plants are ready to be thrown out. More will be said regarding the use of cyanide for growing plants under the head of fumigation.

After the house has been thoroughly fumigated, and all insect life destroyed, careful attention to see that plants taken into it are free of all pests will be the next thing. This can be accomplished by dipping all cuttings or potted plants before they are taken into the house, either in a strong solution of soapsuds, or a ten or fifteen per cent. mixture of lemon oil or fir-tree oil. No doubt other materials could be used, but they have not been experimented with, and the soap solution is perfectly satisfactory, as well as cheap and simple to make. Any good soap, such as Ivory, will do, and should be used at the rate of about one pound to the gallon of water, the plants being immersed in the solution for at least several seconds, so as to become thoroughly wet in every part. Of course, plants that are grown in seed-beds that are not liable to become infested need not be dipped; otherwise they should be. Mealy bugs, aphids, red spiders, thrips, scale insects and doubtless others may be carried into the houses in the fall upon cuttings, and all except the scale insects can, in the writer's opinion, be practically eliminated by a combination of the two measures suggested. The scale insects can only be kept out by a careful inspection, and throwing out of all infested stock, or by very careful washing of the infested plants to remove the scale.

SYRINGING WITH WATER.

Many florists and gardeners depend almost entirely upon the use of water for the control of insect pests, and where a good pressure of water is obtainable very little else is necessary to keep down most of them. A thorough washing off or syringing once or twice a week will prevent the young from getting a foothold, provided the pressure is sufficient to knock them off the plants. Mealy bugs and young scale insects, if knocked off in this way, are usually unable to regain the host, and will perish, but plant-lice are not so easily destroyed, and even if knocked from the plants, many will succeed in crawling back. However, their numbers may be kept down by persistent syringing, provided the plants are not too susceptible to injury by excessive watering. The greatest drawback to the control of insects by syringing is the fact that in order to wash all of them from the host plant it is necessary to use much more water than is required for an ordinary watering, and too much water is a serious detriment to the plants, in many cases. It will often destroy a delicate flower, and some kinds of foliage will not bear wetting, so that it is often impossible to syringe sufficiently to destroy the pests. There is little doubt that the red spider can be effectually controlled upon carnations and other plants by the process of syringing, as the mite is partial to a dry atmosphere, being unable to thrive in dampness, but, unfortunately, carnations will stand but little wetting, and hence the mites are often left to breed undisturbed. Upon plants that are not easily injured by wetting the red spider can be kept down by one or two syringings a week.

A good nozzle of some sort is an indispensable aid in syringing, as it not only enables the operator to more effectually cover the plant, but it also greatly increases the force of the stream, and adds to the certainty of dislodging the pests. Any nozzle that permits of regulation of the fineness of the stream or spray is acceptable. It is desirable to be able to reduce the force of the stream when operating upon small, weak plants; otherwise they may be broken or damaged.

Ornamental palms, which are particularly likely to become infested with scale insects, such as the circular scale, the soft scale, etc., may be effectually cleaned by laying each leaf flat upon a smooth surface, and directing a strong stream of water against it for a short time. If the pressure is good the scale will be torn loose and destroyed. A large palm may be cleaned in this way in a few moments. The only requisites are a good pressure, a good nozzle, and a smooth surface upon which to lay the leaf.

Where only a weak pressure is obtainable, syringing is by no means so successful. Mealy bugs, plant-lice, scale insects, thrips, etc., are not injured by water unless washed from the plants, and it is impossible to dislodge them without force. In the absence of a good pressure, therefore, some other means of handling them must be utilized.

FUMIGATION.

Treatment of greenhouses by fumigation in one form or another is, without doubt, the cheapest, most effective, and the least troublesome of all methods where such treatment is possible. It has the great advantage of reaching every part of the infested plants, whereas in many other methods of treatment, notably syringing and spraying, it is next to impossible to avoid missing some parts of the plants. The only insects not affected by fumigation are those that are working inside the plant tissue, or in some other place where the gas or fumes cannot reach them. It is not meant by this that no other insect will escape death in an ordinary fumigation, as it is a well-known fact that some usually do survive. The reason for their escape, however, if the work has been properly done, is to be found in their power to resist the particular fume or gas that has been used, rather than that they have not been reached by it. Unfortunately, there is a limit to the amount of any poisonous gas or fumes which a plant can withstand, and it not infrequently happens that the limit is less than that which will prove fatal to all the insects. Consequently we have some of the pests usually surviving the treatment. Nevertheless, experimentation has shown that many plants will stand a fumigation with some one of the materials that will prove fatal to most of the pests, and with this class of plants no other method of treatment can be used with as satisfactory results.

Several different materials may be utilized for fumigating, the particular thing to be used depending upon the insect to be combatted, and the kind of plant that is to be treated. The common fumigants are tobacco stems, tobacco punk, tobacco extracts (variously known as Nikoteen, Rose-leaf Extract, etc.), sulphur and potassium cyanide.

Tobacco Fumigation.

The best known and most widely utilized fumigant is some form of tobacco, such as the stems and leaves, or tobacco punk (a proprietary article), which are burned in the houses, the fumes thus generated being depended upon to kill the insects. This is pre-eminently a treatment for aphids, or plant-lice, and is of very little use against any other pest. As a treatment for the plant-lice of roses and chrysanthemums it is quite satisfactory, especially the tobacco punk, but for the aphis of the violet it is a failure, as the violet is injured by the tobacco fumes, which cause a spotting of the leaves. The method has one disadvantage in that it is not as effective against insects infesting plants that are upon low benches, or not elevated at all, as it should be. The fumes are light, and unless used in excessive amounts will not become strong enough near the floor of the house to kill the plant-lice.

The tobacco leaves or stems are either placed on the floor of the house, or in shallow pans on the floor, and allowed to burn slowly, so as to form a dense smudge. The punk may be hung to the benches, or placed upon the floor, as with the leaves and stems. While the punk is more expensive, it is more effective and satisfactory, as it gives off a heavier and stronger fume than can be obtained by burning tobacco leaves and stems.

The tobacco extracts, such as Rose-leaf and Nikoteen, when used as fumigants, are diluted with a given quantity of water, and then vaporized, either by heating over an oil stove, or by throwing hot irons into the pans. The difficulty with this method is that heating over an oil stove does not vaporize the extract fast enough, and it is an impossibility to throw hot irons enough into the pans to completely vaporize all of its contents. What is doubtless a more satisfactory method of producing the vapor consists in using a plumber's soldering lamp to give the heat. With these lamps the flame can be blown directly into the liquid, causing it to vaporize much more quickly than in any other way. When properly vaporized the fumes from the tobacco extracts are fully as effective as those from burning punk, and the treatment is fully as satisfactory. However, fumigation with tobacco fumes of any kind is effective only in controlling aphids or plant-lice. Mealy bugs, red spider, scale insects and white fly are not affected by it, except to a very slight extent.

Fumigation With Sulphur Fumes.

The fumes obtained by burning sulphur are known to be an excellent insecticide under some conditions, but are not safe for use in treatment of greenhouses. However, as a treatment for mildew, in many houses the practice is followed of sprinkling the heat pipes with sulphur, where it is slowly oxidized with the formation of sulphur dioxide, which probably has some slight insecticidal value. The oxidation of the sulphur is too slow to cause the giving off of sufficient sulphur dioxide to hurt the plants, but enough is given off to act as a deterrent, at least to a slight extent, to insect propagation. It is impossible, however, to use sulphur fumes successfully as a direct fumigant, owing to the great danger of injuring the plants.

Potassium Cyanide Fumigation.

The use of potassium cyanide as a fumigant for greenhouses has quite recently been recognized as a practicable and entirely satisfactory treatment, when properly handled, for many pests. For a long time it was regarded as too dangerous to use with growing plants, but careful and repeated trials have demonstrated that it can be used with safety with a considerable number of different plants, and it is probable that properly handled it may be used with nearly all that are grown in greenhouses. The materials are cheap, the process of fumigation not at all complicated, and the results to insects so much more deadly than with any other method of fumigation, that could the florist be entirely certain just what amount of the gas any certain plant would successfully withstand, it would doubtless soon come into general use for combatting certain insects. This is a point that can only be determined by actual and repeated trials, and so far no one has ever taken up this work and carried it through for all the different species of greenhouse plants, although considerable work was done along that line at one time by the United States Department of Agriculture. In the course of the preparation of this bulletin a number of tests were made of different strengths of the gas and times of exposure upon numerous of the more common plants grown under glass. It was found that the amount of the gas which different plants will withstand successfully varies widely. Violets are not injured by an exposure to a charge of fifteen hundredths of a gram per cubic foot of space (or 5.3 ounces to a thousand cubic feet), while Heliotrope and some other plants are unable to withstand a charge of one-fifth that strength. The table on the following page shows the amount of cyanide and the time of exposure that may be used with safety in fumigating a number of the common greenhouse plants.

The results set forth in this table were arrived at by fumigating the plants enumerated with varying amounts of the gas and different lengths of exposure, the fumigating being done for the most part in a tight box. Where possible the test was repeated under actual greenhouse conditions, in order to make sure that the effects when the box was used would not be different from the effects in a greenhouse. The amounts given do not represent in all cases the maximum amounts, either of cyanide or exposure, that were given without injury to the plants, but are rather the amounts that are believed to be perfectly safe.

Table showing amounts of potassium cyanide used and length of exposure given to various plants without injury.

Plants.	Cyanide per 1000 cu. ft.	Length of Exposure.	Remarks.
Voilet	4 ozs.	2 hours	
Primula	1 oz.	Overnight	
Chrysanthemum	¾ of an oz.	Overnight	Old plants will stand more.
Begonia	1 oz.	Overnight	
Nasturtium	1 oz.	Overnight	
Alternanthera	1 oz.	Overnight	
Lantana	1 oz.	Overnight	
Verbena	1 oz.	Overnight	
Orchid	1 oz.	Overnight	Tried but once at this strength.
Snapdragon	¾ of an oz.	Overnight	Tried but once.
Asparagus fern	¾ of an oz.	Overnight	Tried but once.
Sweet pea	¾ of an oz.	Overnight	Tried but once.
Coriopsis	¾ of an oz.	Overnight	
Mignonette	¾ of an oz.	Overnight	
Carnation	¾ of an oz.	Overnight	Does not kill red spider.
Croton	2 ozs.	Overnight	Only two varieties tested.
Cyclamen	2 ozs.	Overnight	
Easter Lily	2 ozs.	Overnight	
Geranium	1 oz.	Overnight	
Rose	1 oz.	Half hour	
Coleus	1 oz.	Half hour	
Sago Palm	1 oz.	One hour	
Acaranthes	1 oz.	One hour	
Tomato	¾ of an oz.	Overnight	Tried many times.
Cucumber	¾ of an oz.	Two hours	Tried but once.
Lettuce	1 oz.	One hour	

The ordinary house is not tight enough to prevent the gradual escape of the gas, so that even if the doors and ventilators are kept closed it gradually finds its way out through cracks and joints between the glass panes, and the strength is slowly lost. A long exposure to a moderate amount of the gas is less likely to cause injury to most plants, and at the same time is more effective against insects than a shorter exposure to a heavy charge.

All fumigation with cyanide should be done at night. Just why the plants are less likely to be injured at this time than during the day time is not plain, but it is nevertheless a fact. Apparently, the plants, when distended and turgid, are more resistant to the action of the gas than when slightly wilted, or it is possible that the higher temperature in the house in day time is responsible for the greater injury at that time. Whatever the cause, there can be no doubt that plants are less liable to injury from cyanide when treated after dark than when treated in daylight.

The cyanide treatment is, as has already been intimated, available for use against practically all the animal pests of greenhouses, but it is especially valuable for use against the white fly, mealy bug, thrips, and the various species of aphids. In houses containing a number of different kinds of plants the writer would recommend the use of, not to exceed three-quarters of an ounce, of cyanide per each one thousand cubic feet of air space. This charge may safely be used with all plants in the above list, and will at the same time be sure to kill all thrips, aphids and white fly, if left in the closed house over night. So light a charge, however, will probably not destroy all the mealy bugs, and it will have no effect on red spider, which seems to be particularly resistant to the gas. Neither will it destroy the eggs of any of the pests. Against scale insects it is useless, as the scale covering protects the insects from any strength of cyanide, which will not be fatal to growing plants. White fly, thrips, mealy bugs, and the aphis of the violet cannot be destroyed by smoking with tobacco, and are exceedingly hard to control by syringing, spraying or dipping. It is against these pests, therefore, that cyanide fumigation is especially valuable. Two tomato houses near Baltimore were fumigated several times for the white fly, which was very abundant, with the result that the fly was almost completely cleaned out for the time being, and the plants entirely uninjured. Another house at Annapolis, however, was treated to the same dose during the day time, and the plants very badly injured. The injury may have been partly attributable, in this instance, to the fact that the tomato plants were wet from a recent watering, but it is more likely that the greater part of the injury was due to the action of the sunlight and cyanide.

Coleuses badly infested with mealy bugs were several times treated at the above strength without injury to the plants, but not all the insects were killed, and it required several repetitions of the treatment to kill them all. The eggs were not affected. Experiments showed that the coleuses will stand a considerably stronger charge than three-quarters of an ounce to the thousand cubic feet, however, and it is the opinion of the writer that it will be found possible to control this pest, as well as the others named, with the cyanide treatment.

Roses and chrysanthemums were repeatedly treated for their respective plant-lice, with excellent results in every case. The gas proved more efficient and cheaper than the tobacco fumigation for the control of these pests.

A carnation house that was badly infested with the red spider, and which was treated with the recommended charge of three-quarters of an ounce per thousand cubic feet, did not show the hoped-for success, however, as the mites were apparently unaffected. Later attempts to increase the charge were made, and it was found that while the plants will withstand a slightly increased charge, the spiders are the more resistant, and it is impossible to kill them, on carnations, at least, without serious injury to the plants.

The process of fumigating with cyanide is quite simple, and not

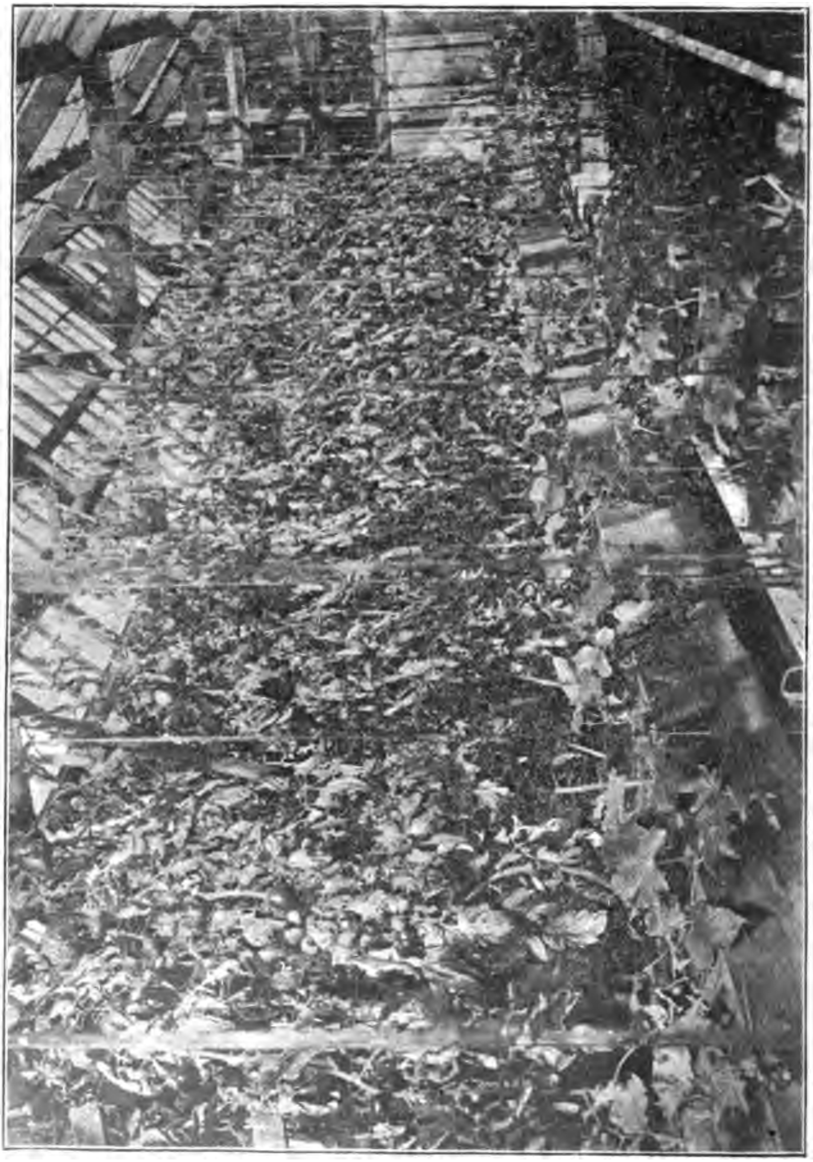

Plate 8—Tomato house fumigated with hydrocyanic acid gas in daytime, showing injury to tops of plants.

at all dangerous, provided the proper precautions are taken. The first requirement is a knowledge of the exact cubic contents of the house to be treated. This should be known accurately, as upon it may depend the success or failure of the treatment. Having obtained the cubic contents of the house, the next step is to carefully weigh out the cyanide, three-quarters of an ounce for each thousand feet of space. If the space to be fumigated is a large one the cyanide should be divided into several equal packages, about three packages for each one hundred feet length of the house. Next, four times as many liquid ounces of water as there are ounces of cyanide are measured out and poured into earthen jars. These jars should be evenly distributed through the length of the house, about three for each one hundred feet of length, and the water distributed equally among them. The jars being placed, and the water in them, one-half as much commercial sulphuric acid as the jar contains water is poured in. Now, making sure that all ventilators are closed, and the house as tight as it can be made, the operator should proceed to the jar farthest from the door, and drop into it one of the bags of cyanide, then walk quickly to the next one, and so on, until the last bag is dropped into the jar nearest the door, when the door should be tightly closed and locked, so that no one can possibly get into the house. The whole operation should not require over ten or fifteen minutes. If an all-night exposure is to be given, it should be set off about 8 or 9 o'clock in the evening, and the house opened and aired before the sun becomes hot in the morning.

In dealing with the violet aphis it is necessary to use a much heavier charge than three-quarters of an ounce to the thousand cubic feet. Luckily the violet is capable of withstanding five or six times as much of the gas as many other plants, so that it is possible to treat it with a charge that is fatal to the aphids. In the foregoing table it will be seen that violets were uninjured by four ounces of cyanide per thousand cubic feet, and a charge of from four to five ounces should be used for the best results in dealing with this insect. The exposure should not be for less than an hour, and in my experiments a two-hour exposure resulted in no injury to the plants. A few of the lice escaped, even with this strong a charge, but the action of the gas was much more satisfactory than was that of the tobacco fumes when used against this pest.

In conclusion, it may be well to repeat the formula for generating the gas. The cyanide and sulphuric acid are obtainable at most large chemical supply houses, and sometimes at drug stores, though the drug-store article is likely to be expensive. It should be borne in mind that commercial sulphuric acid, and not the chemically pure article, is what is wanted. The potassium cyanide should be 98 per cent. pure. The following are the proportions in which the chemicals should be used to obtain the best results:

Potassium cyanide, one ounce.

Water, four liquid ounces.

Commercial sulphuric acid, two liquid ounces.

These proportions should not be varied to any considerable extent.

DUSTING.

The dusting of plants with insecticides is an old practice, but has, to a great extent, been replaced by spraying and fumigation. It is still practiced to some extent, however, in a number of houses. Dusting with Paris Green, Helebore, Pyrethrum powder, or other stomach poison, is a satisfactory treatment for most all of the leaf-eating insects, such as slugs, caterpillars, etc. The poison is best mixed with flour or air-slacked lime, and applied with a dust blower, or, if this instrument is not available, it may be put in a cloth bag and dusted over the plants by hitting the bag with a stick. Not many biting insects are found infesting greenhouses, and it is usually easier to remove such as do stray into the houses by hand than to go to the trouble of dusting with a poison.

Dusting plants with sulfur, as is generally practiced for controlling mildew, acts as a deterrent at the same time for plant-lice and other pests, but is not profitable as a means to combat insects alone.

Tobacco dust is also partially effective against certain pests that infest foliage, but is principally valuable as a remedy for root-infesting forms. Finely ground tobacco leaves or stems, or the sweepings from large tobacco storage houses, if mixed with the soil about the roots of plants, will discourage injury by wireworms, earthworms, and other pests that infest the roots. The tobacco acts not only as a preventive to the work of the worms, but will serve as a good fertilizer as well to many plants.

Lime, kainit, or other salty fertilizers sprinkled over the surface, or mixed with the soil of the benches, will also tend to restrict injury from these root-eating forms.

SPRAYING AND DIPPING.

The application of insecticides in liquid form, either by spraying upon the plants, or by dipping the plants in the solution, is one of the most effectual ways of controlling pests of the greenhouse. Both stomach poisons and contact insecticides may be applied in this way. The greater part of the injury to greenhouse-grown plants is due to sucking rather than biting insects, so that there is comparatively little use for stomach poisons in any form. About the only leaf-eating insects likely to be found upon indoor plants are stray caterpillars, and these may be easily removed by hand. The slugs (or snails, as they are erroneously called) are not so easily caught as the caterpillars, however, as they feed only at night. Spraying plants with water in which is a small amount of Paris Green, about a teaspoonful to two gallons of water, will help to get rid of them.

It is in the handling of the sucking insect pests, therefore, that spraying and dipping are chiefly employed. For this class of pests some form of contact insecticide must be used, and these generally take the form of a soap solution, or an oil made to emulsify with water. Tobacco water, or tea, as it is sometimes called (being obtained by steeping tobacco leaves in hot water) is the best remedy yet found for thrips, if we except the cyanide fumigation. A pound of tobacco is steeped for half an hour in a gallon of water, and the plants sprayed with the solution. Thrips, owing to their feeding habits, are extremely hard to reach with a contact insecticide, but the presence of the tobacco water acts as a repellant, and largely prevents injury to the buds. The tobacco water is also useful for destroying the plant-lice of the rose and chrysanthemum and the mealy bug. Several tobacco extructs are manufactured by various firms, and are applicable to the same conditions. They are rarely ever effective at the strengths recommended by their manufacturers, however, and are not only more expensive, but are little, if any, more effective than the home-made extract.

In the experiments with different emulsified oils two proprietary remedies, viz., Fir-tree Oil and Lemon Oil, were used, as well as several ~~different strengths~~ of kerosene emulsion. The latter proved unsatisfactory for the most part, as it was extremely difficult to avoid injuring the tender foliage of the plants with it. Fir-tree Oil and Lemon Oil, both of which are quite expensive, are simply oil rendered miscible with water. The manufacturers recommend their use at one part of oil to 40 to 60 parts of water. At this dilution neither oil is sufficiently effective to pay for its use, but the proportion of oil may be greatly increased without danger of injury to the plants. When used one part of oil to fifteen or twenty parts of water they are both decidedly effective remedies for the rose aphis, chrysanthemum aphis, and the various other kinds of plant-lice, provided the application is carefully made. The oils mix readily with water in any proportion, and are perfectly safe to apply to any kind of foliage at the above-mentioned strength of one part oil to fifteen or twenty parts water.

A remedy, cheaper and as safe and effective as these oils, however, for the class of insects against which the oils are available, can be made by dissolving three or four ounces of any good laundry soap in a gallon of water. A good quality of soap should be used, as one containing a large proportion of impurities might result in injury. The soap, to be dissolved quickly, should be sliced into boiling water, and it must be completely dissolved, as small chunks of soap will otherwise be left upon the leaves, and may injure them. Of all the different materials used by the writer for spraying and dipping plants this simple soap solution proved the most desirable in many ways. It was equally as effective as the oils and tobacco extracts, and gave no signs of injury to the plants. It is easily prepared, and does not leave an objectionable coating upon the leaves, as do the tobacco extracts. Further than this, it is much cheaper than any of the patent insecticides.

Whale-oil soap seems to be about the only treatment available for the scale insects that infest greenhouse plants, aside from that of washing them off with a strong pressure of water, as already mentioned. It may be sprayed upon most of the plants liable to infestation with little or no danger of injury. Crotons, cycads and palms are most liable to become infested with scale insects, and all may be safely treated with this soap, using one pound of the soap to a gallon of water. Ferns, which are especially likely to be attacked by the hemispherical scale, cannot be sprayed with whale-oil soap, but should be treated with either Lemon Oil or Fir-tree Oil, either of which are fairly effective.

The writer's experience with spraying and dipping plants leads him to believe that where dipping is possible it is much to be preferred. Even with very careful work it is next to impossible to wet every part of a plant by spraying, and at the same time a great deal of the mixture is necessarily wasted in the process. Of course, plants that are planted in benches cannot be dipped, but those in pots can be dipped with far better results than will be obtained from spraying. If completely immersed in the mixture, the whole plant will be wet, and all insects upon it come in contact with the insecticide. A lot of potted chrysanthemums were completely freed of the black aphids by one thorough dipping in the Lemon Oil emulsion, using much less of the oil than would have been necessary for one thorough spraying, whereas a half dozen careful sprayings failed to completely eradicate the pests upon a similar lot of plants.

To dip plants successfuly and expeditiously, a deep vessel (something on the order of a milk can, with open top), that will allow complete immersion, with as little bending of the plant as possible, should be provided. A deep bucket will do, if the plants are not too tall. Whatever the vessel used, it should not have too great a diameter, as the greater the diameter of the receptacle the more of the spray mixture necessary to cover the plants. The plant is plunged top first in the mixture, the operator holding it by the pot, and after being allowed to remain immersed for a few seconds, or long enough to become thoroughly wet, it may be returned to its place on the bench. This process is somewhat slower than spraying, but the added effectiveness, coupled with the great saving in the amount of the spraying material used, will more than balance the extra labor.

In conclusion, the author wishes to acknowledge the co-operation of Mr. George Morrison, superintendent of the Mrs. Barton-Jacobs estate, Baltimore, and Mr. Ernest Ehle, superintendent of the greenhouses at the United States Naval Academy, Annapolis, who so kindly permitted the use of their houses in which to carry on some of the experiments; also Mr. Thomas White, of the Maryland Experiment Station, and Mr. C. A. Reed, of the Maryland Agricultural College, for assistance, and the Bureau of Entomology, United States Department of Agriculture, for identification of specimens.

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SWEET CORN INVESTIGATIONS.

By M. N. STRAUGHN.*

INTRODUCTION.

The work reported upon in this bulletin was begun at the suggestion of Director Patterson in order to make a supplementary study to the matter presented in Bulletin No. 96 of this station, and also to get some preliminary data for use in taking up the systematic breeding of sweet corn. The breeding of sweet corn for seed is very important for Maryland, owing to her large interest in canning this product and also in supplying the city trade with green ear corn.

Maryland's interest in sweet corn can be better appreciated when it is realized that she stands fourth among the States in the production of canned corn and packs annually about one million cases,† or about one-eighth of all that is packed in the United States. For a small State to maintain this position it is quite necessary that improvements be made in the yields per acre and that constant attention be given to every point that may have a tendency to better the quality.

Most of the sweet corn that is planted in Maryland is grown in the New England States and in Northern Ohio. The reason for farmers purchasing seed from the North is due to the prevailing opinion that Northern grown seed will give a sweeter product than the home grown.

From the habits of the plant this idea and practice did not seem entirely rational, and it appeared that for good yields seed should be acclimated and that quality could be improved by breeding. Many farmers hesitate to grow sweet corn, owing to the difficulty in getting good stands and some years owing to the high price of seed. Inquiry has shown that these difficulties are attributed to early frosts in the sections growing sweet corn seed, cutting down the quantity of seed available and injuring the germinating power of that which is placed on the market.

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†Two dozen cans to a case.

*Resigned March 1st, 1907, to take charge of Sweet Corn Investigations with the United States Department of Agriculture.

The results set forth by Dr. Stabler in Bulletin No. 96 demonstrate beyond a doubt the possibility of growing sweet corn seed in Maryland and showed the manner in which profits could be increased by the home production of seed. Several Maryland canners have grown their own seed for years, and thus secured strains or varieties which were specially adapted to their requirements and thus enabled them to establish enviable reputations for their pack of corn.

EXPERIMENTS CONDUCTED.

The work reported upon in this bulletin may be classified under the following heads:

1. Methods of Determining Sugar in Sweet Corn.
2. The Results of the Analysis of Different Varieties of Sweet Corn.
3. A Study of the Composition of Sweet Corn for the Purpose of Establishing a Method for Breeding.
    - (a) The Relation of the Composition of Corn in the Matured (dried) and Green or Edible State.
    - (b) The Relations of the Composition to Physical Characteristics.
4. The Breeding of Sweet Corn; Results of Work to Date.
    - (a) Effects of the Ear to the Row Method of Breeding Sweet Corn.
    - (b) Upper vs. Lower Ear for Sugar Content.
    - (c) General Points to Be Observed in Selecting Seed Corn.
5. A Study of the Changes in Corn From Field to Table.
6. Observations on the Proportion of Husk, Grain and Cob.
7. Composition of Corn Grown in Different Latitudes.
8. The Composition of Sweet Corn.
    - (a) Dried Corn.
    - (b) Green Corn (ready for table use).
    - (c) Canned Corn.
9. A Study of the Enzymes in Green and Dried Corn.
10. Relation of Variety to Insect Ravages.

METHODS OF ANALYSES.

The methods of analyses were those followed by the Association of Official Agricultural Chemists, except in the determination of sugars. The usual methods of determining sugars was not found to be adapted to sweet corn, and in order to overcome the difficulties encountered the following method was devised.

METHOD USED FOR THE DETERMINATION OF THE SUGARS.

The method used and found practical was as follows:

Weigh four grams of the sample into a one hundred cubic centimeter flask. Add fifty cubic centimeters of boiling 40 per cent. alcohol. Boil on the steam bath for two hours. Make nearly to volume with 95 per cent. alcohol. Cool to room temperature. Make to one hundred cubic centimeters volume. Shake and allow to stand until clear. Draw off fifty cubic centimeters. Add fifty cubic centimeters of water. Drive off the alcohol. Wash into a one hundred cubic centimeter flask. Add two to five cubic centimeters of sub-acetate of lead and two to five cubic centimeters of alumina cream. Throw out the lead with sodium carbonate. When cool make to volume; shake and filter. Take twenty-five cubic centimeters of the filtrate with five cubic centimeters of water; add fifty cubic centimeters of Sohxlet's modification of Fehling solution; bring to boiling; boil two minutes; add one hundred cubic centimeters of recently boiled distilled water. Filter immediately through a tarred Gooch (porcelain) crucible; wash with boiling water; and finally with a little strong alcohol and some ether. Dry at 100°C. for one-half hour; cool in dessicator and weigh as Cu_2O. From this, the corresponding weight of invert sugar may be obtained. Fifty cubic centimeters of the remaining filtrate is inverted according to the method of Clerget, and the sugars are determined as above.

COMPOSITION OF DIFFERENT VARIETIES OF SWEET CORN GROWN IN DIFFERENT PARTS OF THE UNITED STATES.

In order to get some idea of the compositin of different varieties of sweet corn and of the same variety grown in different sections all the samples that could be procured were analyzed. Unfortunately, the source of the seed of many of the samples could not be learned, and it was impossible at the time of starting the work to obtain the same variety grown at many different places or at a sufficient range of latitudes and altitudes to give all of the data desired. There were forty-one samples of seed procured. These represented twenty-nine varieties, and were grown in at least seven different States. The results of the analysis are set forth in table one.

An examination of these results show that there is a considerable range in the sugar content of the different varieties. The sugar content, as manifested by these results, do not show in favor of any particular latitude. The early varieties seem, as a rule, to have less sugar than the later varieties, and Stowell's Evergreen, the variety which is recognized as the standard and most used for main crop and canning in this State, averages the sweetest, regardless of the place where grown.

In view of these results, it would seem that it was possible to grow as sweet a corn in this State as in the Northern States, and, again, these results would seem to indicate that by careful selection and breeding it would be possible to grow better and sweeter corn than the average and that it was a profitable line of research to pursue.

TABLE I.

Showing the composition of different varieties of Sweet Corn grown in different parts of the United States.

No.	NAME	Where Grown	Moisture	Ash	Protein	Fat	Crude Fibre	Reducing Sugars	Cane Sugar	Total Sugar	Pentosans	Starch
1	Earliest Sheffield	Ohio	10.07	1.63	11.85	8.15	1.97	1.68	2.23	3.91	6.63	55.79
7	Early Fordhook	"	9.50	1.90	12.29	8.49	1.75	0.62	2.00	2.62	6.59	54.86
30	Early Minnesota		9.60	1.87	10.71	8.56	1.79	1.22	1.59	2.81	7.05	57.61
31	Early Champion		9.41	1.86	11.41	7.97	2.19	1.80	1.97	3.77	6.89	56.50
32	Early Mammoth		9.41	1.77	11.67	8.31	2.10	0.90	2.27	3.17	7.23	56.34
8	First of All	Ohio	9.53	1.72	11.93	7.88	2.13	0.88	3.43	4.31	6.84	55.66
10	Perry's Hybrid	"	9.77	1.73	11.58	8.31	1.97	0.41	2.93	3.34	6.65	56.65
15	Truckers Early		9.33	1.57	10.79	7.55	2.19	1.18	2.37	3.55	6.35	58.67
23	Cory's Extra Early		9.54	1.80	12.72	8.42	2.12	1.33	3.30	4.63	6.50	54.27
34	Crosby's Early		9.60	1.90	11.23	7.82	1.94	0.56	3.59	4.15	6.27	57.09
38	Stabler's Early	Md.	8.99	1.70	10.88	8.11	2.00	0.79	2.39	3.18	6.35	58.59
12	Cory's White Cob	Ohio	9.99	1.79	12.20	7.50	2.19	0.83	2.76	3.61	7.04	55.68
37	Squantonn		8.56	1.79	10.97	8.68	1.80	0.51	2.94	3.60	6.39	58.21
39	Black Mexican		9.55	1.80	12.02	7.86	1.82	0.42	3.44	3.86	6.45	56.64
41	Peep O'Day	Minn.	10.01	1.84	10.79	7.86	2.00	1.28	2.02	3.30	6.70	57.50
3	Golden Bantam	Conn.	9.99	1.82	11.50	7.86	2.00	0.21	4.95	5.16	5.96	55.69
5	Cosmopolitan	Ohio	9.71	1.71	11.67	7.64	1.86	1.36	1.73	3.09	6.51	57.81
9	Henderson's Metropolitan	"	8.76	1.85	12.20	8.38	2.01	0.58	2.15	2.73	6.36	57.71
36	Kendall's Early Giant		9.54	1.84	11.02	7.92	2.00	1.10	2.99	4.09	7.10	56.49
25 L	Salzer's Imp. Evergreen	Minn.	9.49	2.07	11.58	7.89	2.47	0.37	2.76	3.27	7.36	55.87
28	Evergreen Sweet	Neb.	9.70	1.74	11.23	8.31	2.23	1.82	2.66	4.48	7.30	55.01
13	Ne Plus Ultra		9.78	1.73	10.88	5.20	2.61	1.17	2.86	4.03	7.75	58.02
14	Hichox		9.74	1.72	11.50	7.44	2.21	1.36	2.81	4.17	6.19	57.03
					11.67	7.43						
16	Egyptian Corn		9.43	1.46	11.58	....	2.15	0.94	2.78	3.82	7.78	56.40
33	Late Mammoth		9.69	1.72	10.62	8.13	2.23	0.59	3.99	4.58	7.34	55.69
4	Winter Evergreen	Ohio	9.86	1.84	11.06	7.61	2.48	1.40	2.91	4.31	7.44	55.40
2	Stabler's Pedigree	Md.	10.04	1.71	10.97	8.30	2.33	1.90	4.02	5.92	7.36	53.37

TABLE I.—CONTINUED.

No.	NAME	Where Grown	Moisture	Ash	Protein	Fat	Crude Fibre	Reducing Sugars	Cane Sugar	Total Sugar	Pentosans	Starch
8	Country Gentleman	Ohio	9.67	1.65 1.67	11.23	7.27	2.18	0.77	3.09	3.86	7.41	56.72
18	" "	Ohio	9.72	1.75	10.44	7.26	2.31	1.15	3.24	4.49	7.26	56.77
19	" "	Conn.	9.19	1.84	11.06	6.82	2.58	1.12	1.66	2.78	7.40	58.33
21	" "	Ohio	8.77	1.71	10.79	7.16	2.42	1.17	3.82	4.49	7.77	56.39
24	" "	Colo.	8.22	1.72	12.29	6.95	2.59	1.66	2.24	3.90	6.74	57.59
26	" "	Minn.	9.49	1.79	11.23	7.89	2.21	1.28	2.24	3.52	6.52	57.35
27	" "	Ohio	10.02	1.82	11.50	7.87	2.62	1.29	2.43	3.72	7.14	55.31
40	" "	......	8.95	1.68	12.02	6.62	2.70	1.09	3.79	4.88	7.50	55.65
11	Stowell's Evergreen	Ohio	9.75	1.82	11.76	8.01	2.44	1.38	3.91	5.29	7.95	52.97
17	" "	......	9.70	1.80	11.93	8.16	2.48	1.37	3.85	5.22	7.88	52.83
20	" "	Conn.	9.27	1.90	11.50	7.55	2.66	1.66	3.90	5.56	7.49	54.07
22	" "	Ohio	8.74	1.72	11.76	7.95	2.58	1.26	3.21	3.47	7.54	56.24
29	" "	Iowa	9.03	1.87	11.50	7.97	2.34	2.05	2.97	5.02	6.94	55.33
35	" "	......	8.62	1.73	10.00	7.22	2.50	1.68	4.59	6.27	7.46	56.20

TABLE II.

Range and Average of Results in Table I. Calculated to Water, free basis.

	Ash	Protein	Fat	Crude Fibre	Sugars			Pentosan	Starch
					Reducing	Cane	Total		
Maximum	2.17	14.06	9.49	2.96	2.23	5.49	7.72	8.71	54.89
Minimum	1.61	10.93	5.65	1.91	1.23	1.76	2.99	6.78	70.13
Average	1.94	12.52	8.47	2.35	2.35	3.11	5.46	7.64	61.62

RELATION BETWEEN THE PERCENTAGES OF SUGAR IN THE MATURED, DRIED CORN (SEED) AND GREEN CORN (EDIBLE CONDITION).

One of the questions which arose was, is there any relation between the percentage of sugars in the green and dried corn? Some preliminary work in 1905 showed that a few rows of kernels could be removed from an ear of corn and the remainder would mature properly. By analyzing this green corn and then the dried corn a comparison of the percentage of sugars in the two stages of development could be made and establish whether any relation exists between the two. Three lots of corn were used for this. Lot 205 being Crosby's variety, 206 and 208 the Stowell's Evergreen variety. The results are in tables 3, 4 and 5.

TABLE III.

Showing the Relation of the Sugar Content in the Mature and Edible Sweet Corn—Crosby's Variety.

BREEDING LOT. No. 205.

Serial Number.	Dried Seed. Total Sugars. %	Green Corn—Edible Condition. Moisture. %	Total Sugars. As Sampled. %	Total Sugars. Calc. to Water free basis. %
205-5-1	4.62	68.65	5.16	16.46
205-5-2	4.50	66.50	4.37	13.04
205-3-5	4.20	64.56	5.59	15.57
205-3-3	4.12	63.54	5.24	14.37
205-2-1	4.04	68.88	4.51	14.49
205-3-2	3.84	65.86	4.18	12.24
205-4-4	3.74	71.64	5.43	19.15
205-6-3	3.70	68.66	5.12	16.35
205-2-3	3.60	61.90	4.65	12.21
205-7-2	3.58	71.18	4.76	16.53
205-3-1	3.42	69.35	3.82	12.46
205-4-2	3.38	62.82	5.03	13.53
205-4-1	3.30	70.57	3.57	12.13
205-4-5	3.02	66.74	5.37	16.18
205-12-2	2.82	71.82	5.83	20.69
Average.....	3.72	67.51	4.84	15.03

TABLE IV.

Showing the Relation of the Sugar Content in Mature and Edible Sweet Corn—Stowell's Evergreen Variety.

BREEDING LOT NO. 208.

Serial Number.	Dried Seed.	Green Corn—Edible Condition.		
			Total Sugars.	
	Total Sugars. %	Moisture. %	As Sampled. %	Calc. to Water Free Basis. %
208-3-4	7.56	73.92	3.87	14.84
208-5-3	7.10	70.68	3.98	13.58
208-7-3	6.58	75.10	3.84	15.42
208-5-1	6.46	72.56	3.43	12.50
208-7-5	6.00	71.90	3.46	12.31
208-8-1	5.98	69.79	3.20	10.59
208-6-5	5.90	70.87	3.02	10.37
208-5-2	5.60	70.11	4.31	14.42
208-4-3	5.54	71.48	2.88	10.10
208-3-1	5.48	73.27	4.42	16.54
208-3-5	5.44	72.96	5.69	21.04
208-6-2	5.16	71.87	3.36	11.94
208-1-5	5.02	74.75	3.89	15.41
208-4-2	4.98	75.30	2.95	11.94
208-1-4	4.98	71.43	2.89	10.12
208-7-4	4.96	75.25	3.53	14.26
208-8-3	4.94	72.58	2.67	9.74
208-3-2	4.94	70.26	4.07	13.69
208-1-3	4.86	73.13	3.39	12.62
208-4-1	4.84	72.78	3.43	12.60
208-4-4	4.75	73.69	2.65	10.07
208-8-4	4.54	71.12	3.61	12.50
208-9-5	4.46	73.13	3.20	11.91
208-1-2	4.42	73.34	3.73	13.99
208-8-5	4.30	70.04	2.45	8.18
208-10-3	4.12	73.62	2.81	10.65
208-3-3	4.12	71.13	3.80	13.16
208-10-2	4.08	71.82	3.07	10.90
208-2-1	4.02	81.38	3.69	19.82
208-9-3	3.98	71.56	3.32	11.67
208-2-2	3.90	76.36	4.16	17.60
208-6-4	3.90	70.48	3.14	10.64
208-4-5	3.78	73.18	3.11	11.60
208-9-2	3.74	71.34	3.38	11.79
208-9-1	3.68	72.88	3.20	11.80
Average.....	4.97	72.43	3.47	12.87

TABLE V.

Showing the Relation of the Sugar Content in Mature and Edible Sweet Corn—Stowell's Evergreen Variety.

Breeding Lot No. 206.

Serial Number.	Dried Seed.	Green Corn—Edible Condition.		
			Total Sugars.	
	Total Sugars. %	Moisture. %	As Sampled. %	Calc. to Water Free Basis. %
206-16-2	5.44	73.65	4.25	16.13
206-14-3	5.22	68.24	4.05	12.75
206-12-4	5.08	74.16	3.43	13.27
206-16-3	5.04	73.00	3.57	13.22
206-4-5	4.82	75.20	4.56	18.39
206-10-1	4.76	70.17	4.22	14.15
206-17-2	4.70	66.12	3.75	11.07
206-9-3	4.66	75.23	3.50	14.13
206-6-3	4.64	69.45	3.46	11.33
206-1-3	4.50	67.95	3.61	11.56
206-1-2	4.48	71.65	4.02	14.18
206-10-2	4.46	71.82	4.04	14.34
206-1-5	4.44	75.98	5.24	21.82
206-12-5	4.44	72.94	3.52	13.01
206-10-4	4.40	69.22	4.51	14.65
206-20-3	4.36	74.52	2.54	9.97
206-16-4	4.36	71.40	4.53	15.84
206-17-5	4.32	69.62	3.65	12.01
296-8-1	4.28	78.99	4.07	19.38
206-11-3	4.24	78.28	4.45	20.51
206-13-1	4.20	69.01	3.28	10.59
206-11-4	4.18	75.68	3.21	21.44
206-12-2	4.12	69.74	3.38	11.17
206-20-4	4.12	68.50	3.06	9.71
206-2-4	4.10	79.63	3.55	17.43
206-16-1	4.06	72.64	4.74	17.32
206-14-1	4.04	71.86	3.30	11.73
206-6-1	4.04	67.13	4.50	13.69
206-8-1	4.02	68.20	2.27	7.14
206-4-2	4.02	74.95	5.06	20.20
206-5-1	4.02	75.49	5.15	21.02
206-13-5	4.02	70.64	2.93	9.98
206-5-2	3.98	73.15	3.93	14.64
206-19-1	3.96	70.11	3.25	10.87
206-18-3	3.94	69.69	4.52	14.92
206-10-5	3.92	74.80	3.98	15.79
206-1-4	3.90	77.02	4.12	17.93
206-18-5	3.90	72.76	3.79	13.91
206-13-3	3.90	69.97	3.34	11.13
206-15-3	3.90	71.82	4.14	14.70
206-2-5	3.86	67.39	3.85	11.80
206-6-5	3.84	71.81	3.01	10.68
206-19-3	3.82	62.77	3.46	9.29
206-15-2	3.80	72.74	3.22	11.81
206-15-5	3.76	78.88	3.85	18.23

TABLE V—*Continued.*

Serial Number.	Dried Seed. Total Sugars %	Green Corn—Edible Condition. Moisture. %	Total Sugars. As Sampled. %	Calc. to Water Free Basis. %
206-16-5	3.76	66.44	3.60	10.73
206-7-1	3.66	72.32	3.83	13.84
206-6-2	3.64	65.82	3.90	11.41
206-2-5	3.62	67.39	3.85	11.80
206-18-2	3.54	70.20	3.54	11.88
206-9-5	3.54	75.98	4.57	19.03
206-8-2	3.54	77.44	2.67	11.83
206-18-4	3.48	79.48	4.15	20.24
206-7-3	3.42	68.59	3.38	10.76
206-19-4	3.40	73.01	2.64	9.78
206-19-2	3.22	69.90	3.51	11.66
206-4-4	3.20	71.50	3.65	12.81
206-7-5	3.20	76.22	2.65	11.13
206-6-3	3.00	69.45	3.46	11.33
206-8-4	2.88	72.96	3.38	12.50
206-13-4	2.66	69.84	6.55	21.72
206-8-3	2.44	75.06	2.62	10.50
Average.....	4.04	72.03	3.80	13.89

An examination of the above tables show no correllation between the sugars of the corn in the two stages mentioned; therefore, in breeding for high sugar content, it will be necessary to make the selection when the corn is in the green, edible or canning stage of ripeness.

AVAILABLE METHODS FOR BREEDING SWEET CORN. SELECTING SEED BY PHYSICAL APPEARANCE.

A careful canvass of the seedsmen developed the fact that they practice several ways of selecting corn that "is the sweetest;" and an examination was made of the ears selected by the two methods most commonly used.

First, ears were selected for their sweetness according to the color of the kernel. An ear whose kernels were of a deep amber color and more or less transparent is supposed to be much sweeter than one in which the kernels were opaque and were white.

Second, kernels having a fine wrinkle are supposed to be sweeter than those with a coarse wrinkle. Mr. W. W. Tracy, Sr., of the United States Department of Agriculture, kindly furnished the corn and assisted in picking our ears of the above types and physical characteristics, and analyses were made of them, which are tabulated below.

PHYSICAL APPEARANCE OF CORN AS AN INDEX TO SUGAR CONTENT.

TABLE VI.

The Relation of the Sugar Content of Corn to the Color of the Kernel.

Deep Amber Color. % of Sugar.	Whitish Color. % of Sugar.
6.14	5.28
5.34	4.58
4.34	4.48
4.32	4.48
4.28	4.44
4.20	4.38
4.00	4.34
3.92	4.32
3.42	3.86
....	3.58
Average...4.44	Average...4.37

The average percentage of sugars for each lot of corn are very near the same, indeed so nearly alike as to prevent any possibility of one's being able to select ears of corn of a high or low sugar content by this means.

WRINKLED APPEARANCE.

By means of the wrinkled appearance of the kernels two lots were selected with a fine wrinkle and two with a coarse wrinkle. A sample was taken from each of the individual ears and separate analyses made.

TABLE VII.

Showing the Relation of the Wrinkling of Corn to Its Sugar Content.

Ears Having Fine Wrinkled Kernels.	Ears Having Coarse Wrinkled Kernels.
Lot No. 1.	Lot No. 1.
5.28%	5.48%*
4.58%	4.28%
4.48%	4.00%
4.34%	3.92%
4.32%	3.42%
Average...4.60%	Average...3.90%

*Omitted from average.

Lot No. 2.	Lot No. 2
6.14%	4.44%
5.34%	4.38%
4.34%	4.26%
4.32%	3.86%
4.20%	3.58%
Average...4.87%	Average...4.10%

Here an apparent relation exist between the wrinkle of the kernel and the percentage of sugars.

The lowest percentage of sugar in the fine wrinkled kernels, is above the average percentage in the coarse wrinkled and the highest percentage of sugars in the individual ears having a coarse wrinkle is much less than the average in the fine wrinkled ones.

THE BREEDING OF SWEET CORN.

Sweet corn is grown in Maryland for two distinct purposes.

First, for canning.

Second, for the market garden trade.

FOR CANNING PURPOSES.

The varieties best suited to the canners' needs are Stowell's Evergreen and Country Gentleman, or Shoepeg. These two varieties seem to be more generally in demand, yet several men engaged very extensively in the packing industry have developed varieties suited to their needs—by years of selecting and growing their own seed.

The Stowell's Evergreen gives a larger yield per acre and packs more cases per ton than most varieties. It usually commands about two dollars less per ton in price than the Country Gentleman. The latter variety gives a more desirable canned product and brings more money per case.

VARIETIES USED IN SWEET CORN BREEDING EXPERIMENTS.

In starting the breeding work a quantity of each of the above varieties was purchased from Everett B. Clark, Milford, Conn., in the spring of 1905. Three plots of each variety were planted—two in Caroline county, two in Harford county and two at the Experiment Station. The ear to row method was used. A sample was taken from each ear and the sugars, protein and fat determined. At the end of the season the rows were harvested separately and an ear conforming to the type desired was selected from each row, and sugars, protein and fat determined in these samples.

By means of these results a comparison of the composition of the parent and progeny can be made, and the influence exerted upon the corn by growing it in Maryland can be noticed.

The results are given in the following Table VIII. The analysis of the parent ear and its progeny are placed one below the other alternately.

TABLE VIII.

Showing Composition of Sweet Corn, Caroline County Breeding Plot.

Grown by F. P. Roe, Greensboro, Md., 1905—Variety: Stowell's Evergreen.

Laboratory Number	Number of Row	Total Sugars	Protein	Fat
Progeny 640	1	7.86%	....	7.67
Parent...........241	22	6.01%	9.83	7.75
Progeny 641	2	4.90%	10.44	7.76
Parent...........245	26	5.24%	10.89	9.70
Progeny 642	3	4.94%	8.34	7.15
Parent...........240	21	3.96%	9.30	7.40
Progeny 643	4	5.72%	7.99	7.60
Parent...........232	13	5.64%	11.06	7.88
Progeny 644	5	4.90%	8.78	7.75
Parent...........251	32	3.21%	10.79	8.34
Progeny 645	6	5.26%	8.16	8.07
Parent...........240	21	3.95%	9.30	7.40
Progeny 646	7	5.14%	8.25	7.41
Parent...........248	28	4.00%	10.44	8.76
Progeny 647	8	5.76%	8.16	7.23
Parent...........240	21	3.95%	9.30	7.40
Progeny 648	9	4.84%	8.34	7.04
Parent...........242	23	5.75%	10.09	7.87
Progeny 649	10	4.74%	8.86	7.63
Parent...........230	11	5.57%	11.23	8.56
Progeny 650	11	4.96%	8.60	7.02
Parent...........240	21	3.95%	9.30	7.40
Progeny 651	12	5.12%	9.04	6.62
Parent...........244	25	4.06%	11.41	8.14
Progeny 652	13	4.86%	8.78	7.65
Parent...........242	23	4.75%	10.09	7.87
Progeny 553	14	5.62%	9.13	6.98
Parent...........238	19	4.45%	10.71	8.17
Progeny 654	15	4.90%	9.83	7.03
Parent...........233	14	5.30%	9.92	7.58
Progeny 655	16	4.76%	8.95	8.02
Parent...........231	12	5.28%	10.18	8.06
Progeny 656	17	4.14%	10.53	7.45
Parent...........240	21	3.95%	9.30	7.40
Progeny 657	18	5.92%	6.32	7.45
Parent...........223	4	5.30%	9.21	8.39
Progeny 658	19	4.82%	9.13	9.02
Parent...........240—	21	3.95%	9.30	7,40
Progeny 659	20	5.00%	9.04	7.45
Parent...........244	25	4.00%	11.41	8.14

TABLE VIII—*Continued.*

Laboratory Number	Number of Row	Total Sugars	Protein	Fat
Progeny 660	21	4.60%	8.07	7.09
Parent 223	4	5.30%	9.21	8.39
Progeny 661	22	6.32%	5.35	7.30
Parent 244	23	4.05%	11.41	8.14
Progeny 662	23	6.08%	8.51	7.29
Parent 222	3	4.69%	11.50	8.97
Progeny 664	25	4.10%	11.50	8.97
Parent 226	7	5.50%	9.56	8.36
Progeny 665	26	4.52%	8.42	7.54
Parent 235	16	5.75%	9.56	8.20
Progeny 666	27	4.60%	10.27	8.05
Parent 230	11	5.57%	11.23	8.56
Progeny 667	28	4.62%	8.34	8.27
Parent 247	28	4.50%	10.09	7.88
Progeny 668	29	4.40%	7.46	8.04
Parent 245	26	5.24%	10.88	9.70
Progeny 669	30	4.08%		7.38
Parent 240	21	3.95%	9.30	7.40
Progeny 670	31	4 08%	9.30	8.12
Parent 227	8	4.54%	9.13	9.70
Progeny 671	32	5.16%	9.13	7.97
Parent 240	21	3.95%	9.30	7.40
Progeny 672	33	6.00%	9.74	8.71
Parent 244	25	4.06%	11.41	8.14
Progeny 673	34	5.08%	7.63	8.39
Parent 248	29	4.00%	10.44	8.76
Progeny .... .674	35	4.12%	12.02	7.65
Parent 251	32	3.21%	10.79	8.34
Progeny 675	36	6.22%	9.39	7.40
Parent 240	21	3.95%	9.30	7.40
Progeny 676	37	5.20%	9.83	7.45
Parent 230	11	5.57%	11.23	8.56
Progeny 677	38	4.80%	9.83	7.82
Parent 240	21	3.95%	9.30	7.40
Progeny 678	39	4.84%	7.81	7.87
Parent 243	24	4.16%	10.62	7.93
Progeny 679	40	4.34%	9.83	7.69
Parent 225	6	4.38%	11.58	8.83
Average of progeny		5 03%	8.88	7.67
Average of parent		4 57%	10 22	8 12

The figures which are marked "Progeny" correspond to the corn to be planted in 1906 and which was grown from the corn corresponding to the figures marked "Parent," the latter being planted in 1905.

An examination of the above table shows the sugar content in the progeny to be higher than it is in the parent. Attention is called to the fact that no attempt was made to secure the ears having the highest percentage of sugars from each row, simply one ear from each row being selected, and that, the one conforming more nearly to the type of corn desired. In the protein the reverse is true; in nearly every instance the parent has a higher per cent. than the progeny, and this is also true regarding the percentage of fat.

In the above work no attempt was made to select ears having a high sugar content, and yet in the greater number of cases the progeny has the higher percentage of sugar. In the next breeding plot, Table IX, two and three ears were selected from each row and a sample taken from each and the sugars determined. Out of eleven rows from which ears were selected for the 1906 breeding plot eight contained ears higher in sugar content than the parent ears, and from no row were more than three ears analyzed. Attention is called to the fact that the parent ears, whose sugar content was the highest, produced progenies with a higher percentage of sugar than any of the other ears and higher than the highest of their parent. Note ear No. 152, whose sugar content was 6.76 per cent. and whose progenies contained 6.98 per cent. and 7.52 per cent. These ears were selected one from the center of the row and one from near each end. It may be said these are the best rows which have been picked. Yes, and this is the idea of the ear to row plot: to pick out the best ears for perpetuation or breeding. This ear No. 152 also serves another purpose, in that it shows the ability of one ear over some others to transmit its qualities.

This ear, raised in Connecticut and having the highest percentage of sugar of any of the 150 ears purchased, and after planting in Maryland produced corn still higher in sugar, showed quite evidently a hereditary tendence rather than being an accident.

Attention is called to the manner in which the ears were selected—one from the center of the row and one from near each end. Then the fact of its being a real difference, and not the result of any advantage it had received in drainage, sunlight or plant food, but to heredity.

Following is a table showing the results of these analyses:

TABLE IX.

Showing the Relative Sugar Content in Parent and Progeny—Stowell's Evergreen Variety.

SWEET CORN BREEDING TESTS.

PARENT EAR			PROGENY	
Serial No.	Total Sugars %	.	Serial No.	Total Sugars %
142	5.30	....	842	6.02
			843	6.22
143	5.20	....	844	4.10
			845	4.12
150	5.88	....	856	6.30
			857	5.42
151	6.44	....	858	6.78
			859	6.24
152	6.76	....	860	6.98
			861	5.04
			862	7.52
153	6.00	....	863	4.26
			864	5.76
154	4.96	....	865	5.56
			866	5.36
			867	4.34
155	4.62	....	868	3.92
			869	4.38
			870	3.82
162	5.02	....	888	5.28
			889	6.32
172	4.12	....	910	4.74
			911	4.84
177	5.18	....	916	5.34
			917	5.40
Average ...	5.42	....	....	5.36

Row No. 9.

(Parent ear, sugars in the dried corn, 5.76%.)

No. of Ear.	Moisture. %	Total Sugars.	
		As Sampled. %	Calc. to Water Free Basis. %
1	72.88	3.20	11.80
2	71.34	3.38	11.79
3	71.56	3.32	11.67
4	69.46	3.55	11.62
5	73.13	3.20	11.91
Average....	71.67	3.33	11.75

Row No. 10.

(Parent ear, sugars in the dried corn, 5.56%)

No. of Ear.	Moisture. %	As Sampled. %	Calc. to Water Free Basis. %
1	76.12	2.33	9.76
2	71.82	3.07	10.90
3	73.62	2.81	10.65
4	73.04	3.20	11.87
Average....	73.65	2.85	10.82

Average of Entire Breeding Lot:

	73.25	3.43	12.82

This is the second season this corn has been grown in Maryland, which may account for the apparent constancy in some of its individual ears transmitting a high percentage of sugars.

The parent ears of Breeding Lot No. 208—Stowell's Evergreen—were selected because of their high sugar content, every one of which contained over 5.56 per cent. of sugar, and even as high a percentage as 7.52 per cent. was found (these being determined in the matured dried corn ("seed"). Yet the average percentage of sugar found in the green corn of this breeding lot was less than the average for Lot No. 206, which did not contain an ear having over 5 per cent. of sugars. This is more evidence of the fact that no relation exists between the percentage of sugars in the green and dried corn.

The maximum percentage of sugars found in any ear of this lot is 21.04, the minimum 9.68, and 12.82 for the average.

A comparison of the rows reveals the fact that while the average percentage of sugars in rows 1, 2, 3, 5, 7 are above the average found in rows 6, 8, 9 and 10, and even the ears with the highest percentage of sugars in rows 6, 8, 9, 10 is not as great as the average for rows 1, 2, 3, 5, 7; and the ears having the lowest percentages of sugars in rows 2 and 3 have a greater percentage than the highest in rows 4, 6, 8, 9, 10. This is very important in breeding, for the parent ear must have transmitted this tendency to produce high percentages of sugars and, furthermore, it would allow of selecting ears other than ones analyzed from these rows (2 and 3, whose ears have such a high sugar content) with some certainty of obtaining progenies with high amounts of sugars.

TABLE XI.

Stowell's Evergreen.

BREEDING LOT No. 206.

Row No. 1.

No. of Ear.	Moisture. %	Total Sugars. In Green Corn. %	Total Sugars. Calc. to Water Free Basis. %
1	66.36	3.20	9.51
2	71.65	4.02	14.18
3	67.95	3.61	11.56
4	77.02	4.12	17.93
5	75.98	5.24	21.98
Average....	71.79	4.04	14.32

Row No. 2.

No. of Ear.	Moisture. %	Total Sugars. In Green Corn. %	Total Sugars. Calc. to Water Free Basis. %
1	79.90	4.46	22.19
2	74.02	2.19	8.43
3	73.26	2.65	9.91
4	79.63	3.55	17.43
5	67.39	3.85	11.80
Average....	74.84	3.34	13.27

Row No. 3.

No. of Ear.	Moisture. %	Total Sugars. In Green Corn. %	Total Sugars. Calc. to Water Free Basis. %
1	74.58	3.45	13.57
2	70.82	4.03	12.81
3	71.26	4.79	16.68
4	74.01	3.83	14.74
Average....	72.67	4.02	14.71

Row No. 4.

No. of Ear.	Moisture. %	Total Sugars. In Green Corn. %	Total Sugars. Calc. to Water Free Basis. %
1	66.75	4.78	14.30
2	74.95	5.06	20.20
3	72.48	5.19	18.87
4	71.50	3.65	12.81
5	75.20	4.56	18.39
Average....	72.14	4.65	16.69

Row No. 5.

No. of Ear.	Moisture. %	Total Sugars. In Green Corn. %	Total Sugars. Calc. to Water Free Basis. %
1	75.49	5.15	21.02
2	73.15	3.93	14.64
3	77.58	3.43	15.31
4	73.32	3.31	12.59
5	73.68	3.73	14.18
Average....	74.64	3.92	15.46

Row No. 6.

No. of Ear.	Moisture. %	Total Sugars.	
		In Green Corn. %	Calc. to Water Free Basis. %
1	67.13	4.50	13.69
2	65.82	3.90	11.41
3	69.45	3.46	11.33
4	71.81	3.01	10.68
Average....	68.55	3.72	11.83
		Row No. 7.	
1	72.32	3.83	13.84
2	72.28	3.34	12.99
3	68.59	3.38	10.76
4	69.30	4.37	14.23
5	76.22	2.65	11.13
Average....	72.14	3.15	12.60
		Row No. 8.	
1	68.20	2.27	7.14
2	77.44	2.67	11.82
3	75.06	2.62	10.50
4	72.96	3.38	12.50
5	76.99	3.25	14.13
Average....	74.13	2.84	10.98
		Row No. 9.	
1	70.98	2.64	9.10
2	71.71	4.75	16.79
3	75.23	3.50	14.13
4	73.88	4.12	15.77
5	75.98	4.57	19.03
Average....	73.55	3.92	14.82
		Row. No. 10.	
1	70.17	4.22	14.15
2	71.82	4.04	14.34
3	69.90	3.75	12.50
4	69.22	4.51	14.65
5	74.80	3.98	15.79
Average....	71.20	4.10	14.24
		Row No. 11.	
1	71.75	3.65	12.60
2	70.82	4.53	15.52
3	78.28	4.45	20.51
4	75.68	5.21	21.44
5	75.80	3.10	12.81
Average....	74.46	4.17	16.33
		Row No. 12.	
2	69.74	3.38	11.17
3	74.85	3.61	14.35
4	74.16	3.43	13.27
5	72.94	3.52	13.01
Average....	72.92	3.48	12.85

Row No. 13.

No. of Ear.	Moisture: %	Total Sugars.	
		In Green Corn. %	Calc. to Water Free Basis. %
1	69.02	3.28	10.59
2	65.00	2.83	8.09
3	69.97	3.34	11.13
4	69.84	6.55	21.72
5	70.64	2.93	9.98
Average....	68.89	3.78	12.15
Row. No. 14.			
1	71.86	3.30	11.73
2	72.00	3.34	11.93
3	68.24	4.05	12.75
4	72.82	3.36	12.36
5	74.97	3.89	15.54
Average....	71.98	3.59	12.81
Row No. 15.			
1	72.74	3.22	11.81
2	71.82	4.14	14.70
3	74.63	5.32	20.97
4	78.88	3.85	18.23
Average....	74.51	4.13	16.20
Row No. 16.			
1	72.64	4.74	17.32
2	73.65	4.25	16.13
3	73.00	3.57	13.22
4	71.40	4.53	15.84
5	66.44	3.60	10.73
Average....	71.43	4.14	14.49
Row No. 17.			
2	66.12	3.75	11.07
4	71.21	3.39	11.77
5	69.62	3.65	12.01
Average....	68.98	3.66	11.80
Row No. 18.			
1	78.99	4.07	19.38
2	70.20	3.54	11.88
3	69.69	4.52	14.92
4	79.48	4.15	20.24
5	72.76	3.79	13.91
Average....	74.22	4.01	15.55
Row No. 19.			
1	70.11	3.25	10.87
2	69.90	3.51	11.66
3	62.77	3.46	9.29
4	73.01	2.64	9.78
5	72.98	2.45	9.09
Average....	69.75	3.06	10.12

Row No. 20.

No. of Ear.	Moisture. %	Total Sugars. In Green Corn. %	Total Sugars. Calc. to Water Free Basis. %
1	73.89	3.59	13.75
2	76.02	4.42	18.43
3	74.52	2.54	9.97
4	68.50	3.06	9.71
Average....	73.23	3.40	12.70
Average of Entire Breeding Lot (No. 206):			
	72.30	3.77	13.61

The parent ears of this breeding lot were furnished by the Bureau of Plant Industry, United States Department of Agriculture, and had been grown in the western part of New York for several seasons. While the average of several rows shows a high percentage of sugars, some ears have fallen low in these rows and do not appear to be as constant in transmitting a high sugar content as Lot No. 208.

TABLE XII.

Crosby's Variety.

BREEDING LOT NO. 205.

Row No. 2.

No. of Ear.	Moisture. %	Total Sugars. In Green Corn. %	Total Sugars. Calc. to Water Free Basis. %
1	68.88	4.51	14.49
2	63.20	4.14	11.25
3	61.90	4.65	12.21
4	72.40	5.59	20.25
Average....	66.59	4.72	14.15
Row No. 3.			
1	69.35	3.82	12.46
2	65.86	4.18	12.24
3	63.54	5.24	14.37
4	70.01	4.21	14.06
5	64.56	5.59	15.57
Average....	66.67	4.61	13.83
Row No. 4.			
1	70.57	3.57	12.13
2	62.82	5.03	13.53
3	60.88	4.61	11.79
4	71.64	5.43	19.15
5	66.74	5.37	16.18
Average....	66.53	4.80	14.34

Row No. 5.

No. of Ear.	Moisture. %	Total Sugars.	
		In Green Corn. %	Calc. to Water Free Basis. %
1	68.65	5.16	16.46
2	66.50	4.37	13.04
Average....	66.57	4.76	14.23
Row No. 6.			
1	81.35	6.05	32.44
2	68.66	5.12	16.35
3	76.50	6.41	27.28
Average....	75.50	5.86	23.92
Row No. 7.			
1	66.60	4.20	12.58
2	71.18	4.76	16.53
Average....	68.89	4.48	14.40
Row No. 8.			
1	77.38	5.64	24.96
2	74.09	5.80	22.48
3	70.57	5.69	19.35
Average....	74.01	5.71	21.97
Row No. 9.			
1	77.06	5.90	25.77
2	82.80	4.46	25.93
Average....	79.93	5.18	25.81
Row No. 12.			
1	71.82	5.83	20.69
2	66.50	6.08	18.15
Average....	69.16	5.95	19.42
Average of Entire Breeding Lot (No. 205):			
	70.43	5.12	17.32

The Crosby's variety is much sweeter than the Stowell's. There is a great variation in the percentage of sugars in the individual ears, but no more than the Stowell's variety shows. The ears from rows No. 8 and 9 are very interesting and will be planted in a plot to themselves next season.

UPPER VS. LOWER EAR FOR SUGAR CONTENT.

During the season of 1906 it was thought desirable to make determinations of the percentage of sugars in the upper and lower ears from the same stalk to show whether any advantage would be derived by selecting either the upper or lower ear for seed. Below is tabulated the results of seventeen such determinations, the ears from the same stalk being placed beside each other.

TABLE XIII.

Comparing the Sugar Content of the Upper and Lower Ears.

Upper Ear			**Lower Ear**		
Serial Number	**Moisture %**	**Total Sugars Calc. to water free basis %**	**Serial Number**	**Moisture %**	**Total Sugars Calc. to water free basis %**
206-2-3	73.26	9.91	206-2-2	74.02	8.43
206-3-5	74.01	14.74	206-3-4	71.26	16.68
206-4-4	71.50	12.81	206-4-3	72.48	18.87
206-5-4	73.32	12.59	206-5-3	77.58	15.31
206-6-2	65.82	11.41	206-6-1	67.13	13.69
206-7-2	74.28	12.99	206-7-1	72.32	13.84
206-7-4	69.30	14.23	206-7-3	68.59	10.76
206-8-1	68.20	7.14	206-8-1	77.44	11.83
206-8-4	72.96	12.50	206-8-3	75.06	10.50
206-9-4	73.88	15.77	206-9-3	75.23	14.13
206-10-2	71.82	14.34	206-10-1	70.17	14.15
206-10-4	69.22	14.65	206-10-3	69.99	12.50
206-11-2	70.82	15.52	206-11-1	71.75	12.60
206-11-4	75.68	21.44	206-11-5	75.80	12.81
205-12-5	72.94	13.01	206-12-4	74.16	13.27
206-13-3	69.97	11.13	206-13-2	65.00	8.09
206-14-1	71.86	11.73	206-14-2	72.00	11.93
Average	71.70	13.29	**Average**	72.35	12.90

Looking at the averages for the two, it will be noted that there is scarcely any difference in them, 13.29 per cent. being the average for the upper ear and 12.90 per cent. for the lower ear. No advantage would be gained in selecting the upper or the lower ear, provided they were of equal development, maturity and vitality. A point of interest in the above set of results is the close agreement of the moisture content of the two ears from the same stalk. Taking the first upper ear to show a low percentage of moisture (65.82 per cent.), it is found that the corresponding lower ear has also a low moisture content (67.13 per cent). This is found to hold true in the majority of cases. This would seem to indicate that the stalk controlled to a greater or less degree the amount of moisture taken up by the ears.

POINTS TO BE OBSERVED IN SELECTING SEED CORN.

In selecting seed corn attention must be given to the habits of the growth of the plant, in addition to the sugar content of the ear. See that the ear which is used for breeding has vitality and give a good stand of strong, vigorous stalks. Select seed from those stalks that are either free from suckers or show little inclination to sucker. Usually it will be well to select seed from those stalks which give two good ears. Select ears that have white silk rather than pink or colored, as the white silked ears will usually have whiter kernels, which will look better in the can, and then the white silk, if any should escape the cleaner and get into the can, will not get dark in processing and show up as badly as the pink and colored silks.

Select typical ears of the variety or strains you are growing. Select ears with small cobs. Also select ears with white cobs, as the kernels from white cobs are whiter than from colored cobs. For suggestions as to harvesting and curing see Bulletin No. 96.

EFFECT OF STORAGE AT VARIOUS TEMPERATURES.

It is well known that sweet corn soon loses its sweet taste, becoming flat and insipid upon standing. A series of investigations were undertaken to show the change in percentage of sugars the corn undergoes and what effect storing in the refrigerator would have.

Three lots of corn were used, two of Stowell's Evergreen and one of Country Gentleman. About fifty ears, all in about the same state of ripeness, were pulled. The sugars determined in a number of ears at once and the remainder stored; one-half at room temperature and the remaining half in the refrigerator. One-third were stored in the husk; one-third were husked, and the remainder were husked and wrapped in oiled paper.

Ears were taken from each lot at the end of 24, 48, 72, 96, 112 and 120 hour periods, and the moisture and total sugars determined.

These results are tabulated below.

TABLE XIV.

	Moisture	Total Sugars
Stowell's Evergreen No. 1	78.03	4.59
Sample pulled and sugars determined at once	75.84	4.74

TABLE XV.

STOWELL'S EVERGREEN NO. 1.

Unhusked room temperature 25° C.

Serial Number	No. Hours Stored	Moisture %	Total Sugars: In green Corn, %	Total Sugars: Calc. to water free basis, %	Remarks
504	24	77.80	3.06		Good condition.
505	24	63.68	3.81		" "
518	48	75.77	2.31		Tasted flat.
519	48	71.26	1.85		" "
542	96	69.05	1.92		Kernels looked wrinkled. Tasted flat and sour.

TABLE XVI.

*Unhusked — Stored in Refrigerator.**

Serial Number	No. Hrs. Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
510	24	77.94	2.80		Tasted flat.
511	24	79.63	3.22		" "
524	48	75.21	2.80		Wrinkled and taste flat
525	48	74.45	2.50		" " " "
548	96		2.38		Kernels very wrinkled and tasted flat.
549	96	76.61	2.17		" " " "

*Refrigerator showed a temperature of 23⅓° C. (74° F.) during first 24 hrs. after that 17° C. (63° F.)

TABLE XVII.

Stowell's Evergreen No. 1.

Ears husked and stored at room temperature 26° C.

Serial Number	No. Hrs. Stored.	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
506	24	75.75	1.81		Wrinkled and very dry.
507	24	67.26	1.59		" " " "
520	48	72.02	1.83		Very much wrinkled.
521	48	74.00	1.78		" " "
545	96	78.61	1.74		Tasted sour.

TABLE XVIII.

Stowell's Evergreen No. 1.

Ears Husked and Stored in Refrigerator.

Serial Number	No. Hours Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
512	24	67.98	2.09		Tasted flat
513	24	76.05	2.59		" "
526	48		2.13		Tasted tough and flat and a little astringent
550	96	74.13	2.26		Tasted flat and sour—wrinkled

TABLE XIX.

STOWELL'S EVERGREEN NO. 1.

Ears husked, wrapped in oil paper, stored at room temperature 26° C.

Serial Number	No. Hours Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
508	24	74.79	2.25		Good condition
509	24	74.46	2.11		
522	48	73.44	1.89		Tasted flat
523	48	75.55	1.83		" "
546	96	73.07	·1.78		
547	96	72.78	1.44		

TABLE XX.

STOWELL'S EVERGREEN NO. 1.

Ears husked, wrapped in oiled paper, stored in refrigerator.

Serial Number	No. Hours Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
514	24	75.66	2.15		In good condition.
515	24	71.36	4.09		Tasted sweeter than 514
528	48	74.83	1.99		Tasted flat.
529	48	75.16	1.69		" "
552	96	77.41	1.69		Appearance good, tasted sour.
553	96	72.84	1.98		

TABLE XXI.

COUNTRY GENTLEMAN NO. 2.*

Unhusked, stored at room temperature 28° C.

Serial Number	No. Hours Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
530	24	75.81	2.17		Somewhat wrinkled, poor taste.
531	24	70.01	2.87		" " "
554	72	61.38	1.74		Wrinkled and tasted sour.
555	72	70.66	2.12		" " " "
578	96	65.85	1.85		Dry and wrinkled.
579	96	68.17	1.65		" " "
602	120	63.22	1.70		
603	120	67.79	1.60		

*—Samples pulled and Sugars determined at once gave................3.04%
................3.96%

TABLE XXII.

COUNTRY GENTLEMAN NO. 2.

Unhusked stored at refrigerator temperature 20° C.

Serial Number	No. Hrs. Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
536	24	68.43	2.63		Good appearance but tasted flat.
537	24	61.31	2.18		" " " "
560	72	66.15	2.86		
561	72	69.27	1.85		
584	96	65.92	1.49		Wrinkled and tasted sour.
608	120	67.53	1.95		Very wrinkled.
609	120		1.83		" "

TABLE XXIII.

COUNTRY GENTLEMAN NO. 2.

Ears husked and stored at room temperature 28° C.

Serial Number	No. Hrs. Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
532	24	64.33	2.04		Wrinkled and poor taste
533	24	66.28	1.46		" " " "
556	72	61.45	1.69		Very dry, wrinkled and sour.
557	72	64.02	1.31		" " " "

TABLE XXIV.

COUNTRY GENTLEMAN NO. 2.

Ears Husked and Stored in Refrigerator 20° C.

Serial Number	No. Hrs. Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
538	24	64.74	2.47		Tasted flat.
539	24	67.21	2.24		" "
562	72	64.23	2.33		Very wrinkled and dry.
563	72	64.58	1.99		" " " "
610	120	59.95	1.69		
611	120	66.77	1.71		

TABLE XXV.

COUNTRY GENTLEMAN NO. 2.

Ears Husked, wrapped in oiled paper; stored room temperature 28° C.

Serial Number	No. Hours Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
534	24	63.37	1.64		Dry and wrinkled, tasted flat
535	24	66.41	2.23		" " " "
558	72	66.22	1.28		Dry, Sour taste.
559	72	63.05	1.97		
582	96	64.83	1.66		
583	96	70.80	1.72		

TABLE XXVI

COUNTRY GENTLEMAN NO. 2.

Ears husked wrapped in oiled paper; stored in refrigerator 20° C.

Serial Number	No. Hours Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
540	24	66.65	2.31		
541	24	67.09	2.04		
564	72	69.42	1.63		
565	72	68.90	1.78		
588	96	65.68	1.58		
589	96	69.28	1.60		
612	120	64.21	1.48		Very dry and wrinkled.
613	120	68.33	1.25		

TABLE XXVII.

STOWELL'S EVERGREEN NO. 3.*

Ears unhusked and stored at room temperature 27° C.

Serial Number	No. Hours Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
566	24	76.77	1.73		Tasted flat, wrinkled.
567	24	76.14	2.19		
590	48	75.91	1.85		Wrinkled and Dry.
591	48	77.56	2.06		" " "
614	72	73.82	1.29		Sample wrinkled, dry and tough.
615	72	71.70	1.84		" " " "
626	96	70.60	1.39		Very wrinkled, tasted flat.
627	96	71.15	1.25		" " "

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* Sugars in fresh corn was 4.00%

TABLE XXVIII.

STOWELL'S EVERGREEN NO. 3.

Ears unhusked; stored in refrigerator at 20° C.

Serial Number	No. Hours Stored	Moisture %	TOTAL SUGARS		Remarks
			In green Corn, %	Calc. to water free basis, %	
572	24	78.33	1.77		Tasted sour.
573	24	75.40	1.75		" "
596	48	73.69	1.80		Wrinkled and dry at bottom of refrigerator.
597	48	74.62	2.08		" " " "
632	72	75.06	1.52		Samples dry, tasted flat.
633	72	74.31	1.85		" " " "

TABLE XXIX.

STOWELL'S EVERGREEN.

Ears unhusked and stored at room temperature 28° C.

Serial Number	No. Hours Stored	Moisture %	TOTAL SUGARS		Remarks
			In green Corn, %	Calc. to water free basis, %	
568	24	73.32	1.45		Dry and wrinkled, taste sour.
592	48	67.28	1.97		Dry and wrinkled.
593	72	77.02	1.44		" " "
616	72	70.90	2.48		Poor appearance, taste tough.
617	72	73.96	1.60		" " " "
628	96	75.49	1.69		Dry and wrinkled, no taste.

TABLE XXX.

STOWELL'S EVERGREEN NO. 3.

Ears husked; stored in refrigerator 20° C.

Serial Number	No. Hrs. Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
574	24	76.29	1.73		Wrinkled and tasted sour.
575	24	73.87	1.75		" " " "
598	48	67.40	2.59		Dry and Wrinkled.
599	48	79.91	3.02		" " "
622	72	72.52	1.74		Wrinkled, taste tough.
623	72	65.84	1.92		
634	96	74.25	1.81		Very wrinkled.
635	96	74.87	1.49		" "

TABLE XXXI.

STOWELL'S EVERGREEN. NO 3.

Ears husked, wrapped in oiled paper, stored room temperature 28° C.

Serial Number	No. Hours Stored	Moisture %	Total Sugars		Remarks
			In green Corn. %	Calc. to water free basis, %	
570	24	75.01	1.91		Sample Dry, taste sour.
571	24	77.66	2.36		
594	48	75.94	1.92		
595	48	75.62	1.41		
618	72		1.54		
619	72	73.40	1.97		
630	96		1.79		Wrinkled.
631	96	76.86	1.32		"

TABLE XXXII.

STOWELL'S EVERGREEN NO. 3.

Ears husked; wrapped in oiled paper and stored in refrigerator 20° C.

Serial Number	No. Hours Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
576	24	77 35	1.55		Taste sour, were on bottom of the refrigerator.
577	24	75.56	1.65		
600	48	71.63	1 88		Good appearance.
601	48	78.50	1.72		" "
624	72	78.14	1.53		" "
625	72	76.58	1.74		" "
636	96		1.58		Taste tough and flat.

In Lot No. 1 the sugars present were 4.59 per cent. and 4.74 per cent. Upon standing twenty-four hours about one-third of the sugars disappeared; the next twenty-four hours another loss was noticed, but when the sugars reached 1.80 per cent. no further loss was noted. The taste was not as good after twenty-four hours as when the sample was first pulled and marked. Changes were noted as the length of storage increased. The results do not show any material advantage to be gained either by husking the ear, wrapping it in oiled paper or storing it in the refrigerator. This is noticeable in the remarks on the taste and the percentage of sugars found.

The work shows that corn should not be pulled until ready for use, and should be put on the market and canned with as little delay as possible after gathering it.

A further study of the changes when stored at much lower temperatures would seem desirable, for if the qualities when just pulled from the stalk can be preserved until it reaches the table by shipment in refrigerator cars the early corn of the South would be much more in favor than at present, and this method would also enable merchants to always keep corn in better condition for the city trade. So far, the present investigation would seem to indicate that the ferments work at very low temperatures and that the original qualities of corn will be hard to preserve.

OBSERVATIONS AS TO THE PROPORTIONS OF HUSK, GRAIN AND COB.

It is important for both the canner and grower that the corn will yield as great a portion of kernel as possible for thus the pack per acre will be large and the canner can afford to pay better prices per ton for the corn delivered to the factory.

In order to get some data as to the relative yields of the different parts, the determinations recorded in Tables XXXIII and XXXIV were made. From thes tables we see that the different ears from the Maryland grown corn showed a range in proportion of kernel of about 23 per cent. This seems like a great range and points out the desirability of giving due attention to getting a higher yield of kernel at the same time of improving the other qualities.

TABLE XXXIII.

Showing Weights of Ear and Various Parts and Percentages of Same.

Stowell's Evergreen, Md.

Serial No.	Wt. Entire Ear.	Wt. Husk.		Wt. Cob.		Wt. Kernels.	
	Grams.	Grams.	Per Cent.	Grams.	Per Cent.	Grams.	Per Cent.
307	565	133	23.54	165	.....	267	47.26
313	519	129	24.86	180	.....	210	40.46
305	495	120	24.24	165	.....	210	42.42
289	475	185	38.95	140	.....	150	31.58
283	447	187	41.84	130	.....	130	29.08
306	445	115	25.84	135	.....	195	43.82
282	445	145	32.58	120	.....	180	40.45
288	430	195	45.35	128	.....	107	24.88
312	427	135	31.62	142	.....	150	35.15
308	408	121	29.66	145	.....	142	34.80
280	395	115	29.11	125	.....	155	39.24
311	368	103	27.99	135	.....	130	35.33
315	363	88	24.24	128	.....	147	40.50
281	350	140	40.00	115	.....	95	27.14
291	330	124	37.58	110	.....	96	29.09
290	325	89	27.38	100	.....	136	41.85
314	285	73	25.61	125	.....	87	30.53
Average..	416	129	31.01	135	.....	152	36.54

TABLE XXXIV.

Summary of Weights of Ears and Percentages of Various Parts of Corn Grown in Maryland, Together With That From Other States for Comparison.

Maryland.

Stowell's Evergreen.

	Wt. Entire Ear.	Husk. %	Cob. %	Kernels. %
Maximum...........	565	45.35	.....	47.36
Minimum............	285	24.24	.....	24.88
Average.............	416	31.01	.....	36.54

South Carolina.

Stowell's Evergreen.

	Wt. Entire Ear.	Husk. %	Cob. %	Kernels. %
Maximum...........	465	46.67	.....	44.09
Minimum............	325	22.39	.....	26.67
Average.............	415	31.85	.....	38.12

CONNECTICUT.

STOWELL'S EVERGREEN.

	Wt. Entire Ear.	Husk. %	Cob. %	Kernels. %
Maximum...........	445	36.88	.....	56.51
Minimum............	310	22.49	.....	29.35
Average.............	381	33.11	.....	38.26

QUALITY OF SWEET CORN GROWN IN DIFFERENT LATITUDES.

In a series of experiments conducted (in co-operation with the Chemical Bureau of the United States Department of Agriculture) to show the influence of environment upon the composition of sweet corn, two varieties of corn were grown at varying degrees of latitude. The results are of particular interest to growers of sweet corn in Maryland, as they confirm the results obtained here and the supposition upon which the work was undertaken that the sugar in corn was dependent upon heat and sunshine, and that as corn was somewhat related to sugar cane that sweeter corn ought to be raised in the South than the North.

TABLE XXXV.

Showing the relative amounts of Sugar in Sweet Corn grown in different latitudes.

STATION	VARIETY OF CORN					
	CROSBY'S			STOWELL'S EVERGREEN		
	Moisture %	Sugars %		Moisture %	Sugars %	
		Edible Condition	Calc. to Water free basis		Edible Condition	Calc. to Water free basis
Clemson College, S. C....	65.84	12.23	35.80	75.54	6.68	27.31
College Park, Md........	....	....	....	78.09	5.78	26.38
New Brunswick, N. J....	....	....	....	69.28	4.26	14.12
New Haven, Conn.......	73.01	7.75	28.64	74.84	5.36	21.30
Orono, Me...............	79.30	6.50	31.40	....	....	....

The above is a summary of the analyses of individual ears of corn made at the time that it was in prime eating or canning condition and represents from twenty to one hundred analyses of each variety made at each station. An examination of the above table reveals the fact that South Carolina, the most southernly located station, produced corn with the highest sugar content, and Maryland stands second. The New Jersey station gave the lowest percentage of sugars, but this was probably caused by a severe drought, occurring just previous to the tasseling of the corn. These results would seem to indicate that sweet corn follows the habits of sugar cane rather than that of sugar beets.

THE COMPOSITION OF SWEET CORN.

The analyses of sweet corn, so far as recorded, have been made by methods which, as already stated, have not been found accurate or satisfactory. Therefore, the following results of the composition of dried, green and canned corn are brought together for comparison.

The complete analysis of Stowell's Evergreen Corn in the green or edible condition showed the following results:

	As Sampled. Per Cent.	Results. Cal. to Water Free Basis.
Moisture........	73.00	.....
Starch and fat...	11.85	43.89
Sugars..........	5.70	21.11
Protein.........	4.59	17.00
Pentosans.......	2.88	10.67
Crude fiber......	1.00	3.70
Ash.............	.98	3.63
Total.........	100.00	100.00

In the following tables are given the results of the determination of protein in the green corn ready for table use, and also the protein and sugar in canned corn.

TABLE XXXIII.

PROTEIN IN GREEN CORN. SUMMER, 1905.

No.	Name.	Moisture.	Protein.	Calculated to Water Free.
295	Cosmopolitan	79.41	2.90	14.08
298	Monarchie	70.31	3.21	10.81
302	Moore's Concord......	76.36	2.83	11.55
303	Triumph	72.56	2.99	10.89
304	Black Mexican.......	72.74	3.01	11.04
	Average	74.28	2.99	11.07

CANNED CORN.

No.	Name.	Moisture.	Protein.	Protein Wtr. Free.	Ttl. Sugars Wtr. Free.
509	Stowell's	76.28	2.79	11.76	9.57
510	“ “	76.41	2.86	12.12	9.49
511	“ “	78.64	2.37	11.09	10.29
513	“ “	76.70	3.24	13.90	9.01
514	Country Gentleman	80.10	2.69	13.52	12.19
516	“ “	81.11	2.58	13.65	11.91
517	” “	80.59	2.53	14.04	12.36
518	“ “	80.19	2.47	12.45	12.52
	Average.........	78.75	2.69	12.81	10.92

The canned corn was grown by F. P. Roe, Greensboro, Md., from the lot of dried corn which has its analysis given in Table VIII.

Bringing the above results with those for dried corn, as given in Table VIII, together for comparison, we have the following:

TABLE COMPOSITION OF DRIED, GREEN AND CANNED CORN.

Results Calculated to Water Free Basis.)

	Dried Corn. %	Green Corn. %	Canned Corn. %
Ash	1.94	3.63	.....
Protein	12.52	17.00	12.81
Fat	8.47	.....	.....
Crude fiber......	2.35	3.70	.....
Sugars	5.46	21.11	10.92
Pentosans	7.64	10.67	.....
Starch	61.62	43.89*	.....

*Including fat.

A STUDY OF THE ENZYMES OF SWEET CORN.

ORGANIZED FERMENTS.

To learn if any organized ferments were causing the disturbance which prevented the application of the usual methods of determining sugars in such material two grams of the sample were treated with each of the following preservatives: Alcohol, sulphurous, salicylic, boracic, benzoic acids and formalin were added to samples of the corn. In each case fermentation was prevented; but, while they reduced the action of the enzymes, they did not entirely prohibit, and the results show that an organized ferment was not causing the trouble. At this time samples of the corn were sent to the Bureau of Chemistry, United States Department of Agriculture, where, by following the method employed here, the results obtained were comparable with our own.

CHECK OF THE ANALYTICAL WORK.

No. of Sample.	% Total Sugar.	Analyst.
212	4.85	Bureau of Chemistry.
	4.90	Maryland Experiment Station.
213	7.00	Bureau of Chemistry.
	6.85	Maryland Experiment Station.
214	5.10	Bureau of Chemistry.
	5.15	Maryland Experiment Station.
223	5.05	Bureau of Chemistry.
	5.05	Maryland Experiment Station.
224	4.30	Bureau of Chemistry.
	4.40	Maryland Experiment Station.
225	5.20	Bureau of Chemistry.
	5.15	Maryland Experiment Station.

This was conclusive proof of the correct manipulation of the method.

ACTION OF ALCOHOL ON STARCH AND SUGARS.

Samples of potato starch, prepared in the laboratory, and samples of cane sugar, were treated with alcohol for seven days; but no sugars were formed nor was the cane sugar broken down.

Next the effect of temperature was tried.

Four grams of the sample was treated with thirty cubic centimeters of water and shaken continuously for one hour. This was made up to a volume of one hundred cubic centimeters with 95 per cent. alcohol, and the sugars were determined according to the official method (page 24, Bulletin No. 46) of the Bureau of Chemistry.

Reducing Sugars.	Cane Sugar.	Total Sugars.
3.07	4.65	7.72

Four grams of the sample were treated with thirty cubic centimeters of water and ten cubic centimeters of 95 per cent. alcohol and shaken for one hour. This was made up to the volume of one hundred cubic centimeters with 95 per cent. alcohol, and the sugars were determined as above.

Reducing Sugars.	Cane Sugar.	Total Sugars.
2.69	4.54	7.23

Four grams of the sample were treated with thirty cubic centimeters of water and ten cubic centimeters of 95 per cent. alcohol (added boiling) and boiled for one hour. This was made to a volume of one hundred cubic centimeters with 95 per cent. alcohol, and the sugars were determined as above.

Reducing Sugars.	Cane Sugar.	Total Sugars.
2.50	4.68	7.18
2.50	4.73	7.23

Four grams were treated with thirty cubic centimeters of water and allowed to stand seven hours. Then 95 per cent. alcohol was added to make to one hundred cubic centimeters volume. This stood over night, and then an aliquot portion was taken and the sugars were determined.

Reducing Sugars.	Cane Sugar.	Total Sugars.
7.99	3.14	11.13

Four grams of the sample were treated with thirty cubic centimeters of water and ten cubic centimeters of alcohol. This stood seven hours and was made to one hundred cubic centimeters with 95 per cent. alcohol. This stood twelve hours, and then the sugars were determined.

Reducing Sugars.	Cane Sugar.	Total Sugars.
3.83	4.05	7.88

These results show that enzymes were present and very active. All of the sugar can be gotten in solution by using water as a solvent, or water and alcohol; but in both cases the sugars increased, varying as the length of treatment varies. The alcohol reduces the enzymic action very perceptibly, but does not prevent it. By adding the alcohol and water boiling, and boiling for an hour, solution of the sugars is complete and action of enzymes is prevented.

In Bulletin No. 13, part 9, of Bureau of Chemistry, United States Department of Agriculture, mention is made of the fact that in the common method of separating the carbohydrates soluble in water from the freshly ground grain or flour it must not be forgotten that precautions are not usually taken to prevent the action of natural enzymes, which all cereal flours contain, during the time of extraction. Under the condition in which ordinary aqueous extraction is practiced these enzymes may become active, and consequently a portion of the soluble material secured may be due to this source. In order to avoid the action of the enzymes, Girard proposes the extraction at a very low temperature. This low temperature is secured by conducting the extraction in a vessel which is surrounded by pounded ice.

METHOD PROPOSED BY GIRARD.

The method employed for the extraction of the sugars in the following table was to treat four grams of the sample with one hundred cubic centimeters of 40 per cent. alcohol for two hours. Sample No. 1 was treated with one hundred cubic centimeters of 40 per cent. alcohol, added boiling, and kept at that temperature for two hours. It was then cooled to room temperature, made to volume of two hundred cubic centimeters with 95 per cent. alcohol, an aliquot portion taken and the sugar determined. In Nos, 2, 3, 4, 5, 6, 7 the alcohol was added at 5°C. and kept at this temperature for two hours, being stirred constantly. It was then made to mark with 95 per cent. alcohol, cooled to 5°C., kept at this temperature and allowed to settle. An aliquot portion of the clear solution was drawn off and the sugars were determined as in No. 1. Nos. 8 and 9 were treated in the same manner as Nos. 2, 3, 4, 5, 6, 7, except that they were shaken at intervals of fifteen minutes for two hours. Samples Nos. 4 and 9, after having an aliquot portion withdrawn, had fifty cubic centimeters of 40 per cent. alcohol added to each and were treated again for two hours. The results show that this solution and continued extraction gave higher results and that in the other instances the extraction was not complete.

TABLE I.

Showing the Effect of a Low Temperature.

	Boiling for two hours.	At 5 degress C., shaking constantly for two hours.						At 5 degrees C. shook at Intervals of 15 Min. for two hours.	
Sample No.......	1	2	3	4	5	6	7	8	9
Invert	0.98	0.00	0.00	0.24	0.40	0.00	0.00	0.60	1.00
Cane.............	3.72	3.03	3.08	3.02	2.91	3.16	3.22	3.14	3.06
Total.............	4.70	3.03	3.08	3.26	3.31	3.16	3.22	3.74	4.06
		4	4d.					9	9d.
Invert............	......	0.24	0.28	......	......	......	......	1.00	0.92
Cane.............	......	3.02	3.42	......	......	......	......	3.06	3.84
Total.............	......	3.26	3.70	......	......	......	......	4.06	4.76

From the foregoing work it is quite evident that enzymes are present and very active, and that the use of preservatives does not entirely prevent their action, but that temperatures above 80°C., or at 80°C., does prevent their action. In cases where water is used as a solvent the enzymes were most active, an increase of one-half per cent. of sugars occurring after this treatment with water. Alcohol slowed their action very much; but boiling the solution entirely destroyed their active properties. The method of treating samples in the cold is not satisfactory, as all the sugars may not be gotten into solution.

A sample of corn was heated in a water oven for five hours, and the sugars were determined by dissolving the sample at room temperature. By treating the sample for two hours with water at room temperature there was obtained 4.74 per cent. total sugars. Treating it in the same manner for seven hours there was obtained 6.05 per cent. total sugars, showing that heating the air-dry sample did not affect the activity of the enzymes. They were only affected by the heat when in aqueous solution.

ACTION OF THE ENZYMES ON POTATO STARCH.

It was thought advisable to try the action of these enzymes on potato starch, and some of this starch was prepared from the potato. This showed a fine appearance under the microscope.

Four grams of sweet corn upon being treated for seven hours with a 40 per cent. alcohol solution gave 7.80 per cent. and 7.91 per cent. total sugars. By adding two grams of starch to the sample and treating as above indicated 8.38 per cent. total sugars was obtained.

This showed that the starch was attacked before all the available material of the corn sample was used, as 11.13 per cent. total sugars was obtained from the same sample of corn without the addition of starch. An examination of the starch under the microscope showed that the granules had been attacked. They appeared as though they had been etched, some being attacked to such an extent as to give the appearance of lace work. It was thought desirable to try this method on other cereals in comparison with the usual method. Barley, oats, rye and malt were selected. In each case four grams of the sample were treated with fifty cubic centimeters of 40 per cent. alcohol. In Column No. 1 the sample was treated with boiling alcohol for one hour, No. 2 at a room temperature for one hour, and No. 3 at a room temperature for four hours.

TOTAL SUGARS.

	No. 1.	No. 2.	No. 3.
Barley	1.82	2.44	3.62
Oats	0.96	1.64	3.00
Rye	3.50	4.34	5.72
Malt	7.60	10.34	13.80

DESCRIPTION OF THE KERNEL.

The kernel was separated into top, middle portion and germ. The part taken for the top was as indicated above the broken line, the middle portion from between the top line and the broken line surronuding the germ (the shaded portion), while the portion for the germ did not include the entire germ, but the center, in order to avoid getting any of the middle layer.

LOCATION OF SUGARS (2).

Two rows of kernels were taken from an ear of sweet corn and ground, this sample serving to represent the whole grain. The remainder of the kernels were separated, as indicated in the diagram. The following results were obtained and served to locate the sugars more or less accurately.

	% Sugars.		
	Reducing.	Cane.	Total.
Whole grain........	0.84	4.07	4.91
Top of grain.......	1.04	3.73	4.87
Germ	0.00	6.27	6.27
Middle section......	0.32	3.44	3.76

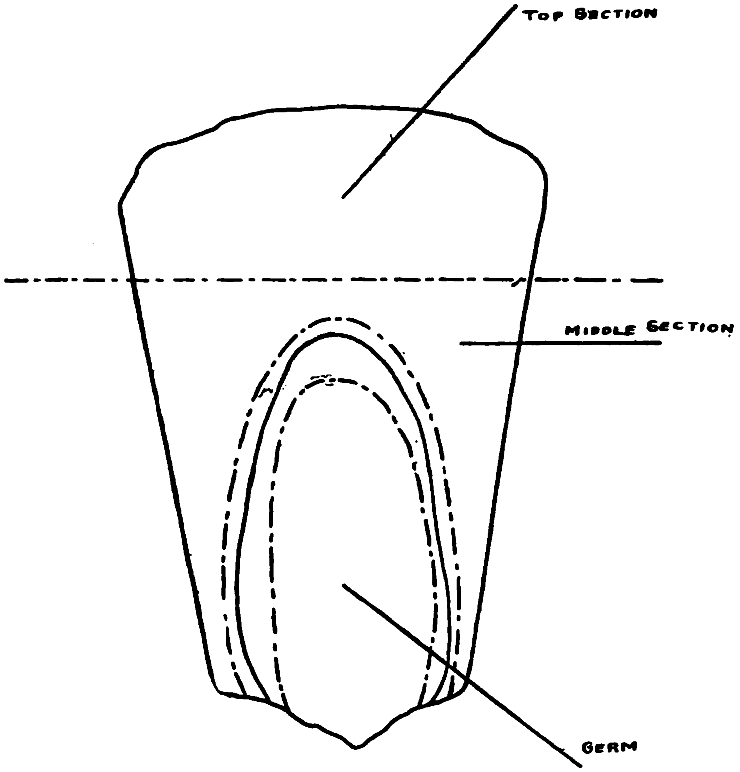
LOCATION OF THE ENZYMES.

In order to locate the enzymes samples of the above, parts were treated with thirty cubic centimeters of water and ten cubic centimeters of starch solution in the cold for four hours.

		Sugars.	
	Reducing.	Cane.	Total.
Whole grain, 10 C. C. starch...	5.16	8.10	13.26
Top of grain, 10 C. C. starch...	7.80	0.00	7.80
Germ, 10 C. C. starch...	11.12	7.80	18.92
Middle section, 10 C. C. starch...	9.00	1.64	10.64

The enzymes are apparently distributed through the entire kernel.

This action of the enzymes is a catalytic one; an instance where the agent does not enter into the compound, but simply is the agent of bringing about the change. An example is where mercury is used as an oxidizing agent in digesting a sample to determine the nitrogen.



There are a number of these enzymes in the body; namely, pancreatin, ptylin and pepsin. In plants it is usually a diastase. One of their characteristics is that they do not increase in numbers.

VARIETAL RESISTANCE TO INSECTS.

In the season of 1905 a thing of especial interest was noticed. Two varieties of corn, Stowell's Evergreen and Crosby's Variety, were planted on adjoining plots. The Crosby's corn had over 50 per cent. of the young plants destroyed by wire worm, and the Stowell's did not suffer a loss of 2 per cent. from them. Both varieties were on land which had received similar treatment for a number of years and they were planted at the same time; in consequence, the failure of the worms to damage the Stowell's variety was attributed to varietal resistance.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 121. SEPTEMBER, 1907

By B. E. Porter.*

THE GROWING AND FATTENING OF BEEF CATTLE IN MARYLAND—PRESENT STATUS OF THE INDUSTRY AND SUGGESTIONS FOR ITS IMPROVEMENT.

INTRODUCTION.

Within the last quarter of a century the production of beef in the United States has made wonderful advancement. The number of cattle handled at the great livestock markets has been increasing from year to year, so that the commercial magnitude of the industry is now very difficult to comprehend. One packing firm alone at Chicago transacts business amounting to a million dollars every twenty-four hours.

But beyond this activity in the commercial centers is the activity which starts on the farm with the production of the crops and feeding the cattle. The question of economic production is no longer an easy one for the cattlemen to solve. Changed conditions have introduced new factors, which have much influence on the profits of the industries.

The object of investigating the beef-cattle industry of Maryland has been to study the methods and practices of the growers and feeders of beef cattle, learn of the actual conditions of affairs and then, from the information and data, collected from the various sources, to offer, if possible, some suggestions which might aid in bringing about an improvement of conditions which would result in increasing the industry.

THE EXTENT OF THE INDUSTRY.

The growing and fattening of beef cattle is one of the largest industries in the United States, and, according to the last reports of the Bureau of Animal Industry, the number of cattle, other than milch cows, has increased since January 1, 1900, from 27,610,054 to 51,556,000, with an increase in valuation from $689,486,260 to $881,557,000. The figures are large, and will at once give an idea of the immense growth of livestock production throughout the country. Maryland does not have so important a part in the beef industry as some of the other States. In number of cattle and total value, Texas and Iowa lead all the other States. The following table will show the total number, farm value and average price of cattle as given for Texas, Iowa and Maryland on January 1, 1906:

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*Mr. B. E. Porter, Assistant Professor of Animal Husbandry in the College, was employed during vacation periods to investigate the beef-cattle industry in this State. This bulletin constitutes his report upon the subject.

State.	Total No.	Farm Value.	Av. Farm Value.
Texas	8,579,739	$101,026,428	$11.78
Iowa	3,432,832	71,299,918	20.77
Maryland	135,319	2,458,068	18.16

Maryland's relative position in the livestock industry is better than the above figures indicate, when it is remembered that Iowa devotes nearly 25 times and Texas 100 times as much area to their production as does Maryland.

The following, taken from the census report of 1900, will show the distribution of cattle over the State:

TABLE I.

Cattle kept in Maryland for Beef Production. Counties.

COUNTY.	Calves under 1 year.	Steers, 1 and under 2 years.	Steers, 2 and under 3 years.	Steers, 3 years and over.	Heifers, 1 and under 2 years.	Cows, 2 years and over.
Allegany County....	1546	636	476	128	868	417
Anne Arundel County	868	243	204	721	386	162
Baltimore County...	4134	309	386	267	2984	799
Baltimore City......	173	18	31	714	55	224
Calvert County......	939	176	218	1177	163	89
Caroline County.....	1175	154	78	30	432	176
Carroll County......	3798	333	410	58	2928	301
Cecil County.........	3209	407	357	177	2021	356
Charles County......	2254	673	726	1573	793	223
Dorchester County..	2060	383	355	1489	797	641
Frederick County...	6776	2332	1976	269	4050	587
Garrett County......	4570	2855	1882	393	1573	1097
Harford County.....	3738	612	2049	1380	2467	343
Howard County.....	1275	263	658	499	822	135
Kent County........	1921	116	75	65	908	474
Montgomery County.	3205	968	1927	1927	1892	449
Prince George's Co..	1342	251	224	349	598	321
Queen Anne's County	2285	164	96	164	1116	334
St. Mary's County...	1404	420	488	1821	475	173
Somerset County....	809	167	121	406	331	214
Talbot County.......	1691	78	104	37	691	321
Washington County.	4439	1809	906	91	2341	345
Wicomico County....	1005	147	139	426	2433	146
Worcester...........	2006	416	347	581	3385	1450
Total.............	56,322	14,010	11,235	14,752	28,506	9.677

The cattle fed in Maryland are handled chiefly in small bunches. This is due to the fact that the farms are relatively small, and that individual farmers are doing the work, and that there are no large organized companies. The number fed by any one man varies; the usual number is from sixteen to thirty, or enough to make a car-load. Still a few men have equipment and capital enough to handle as many as from one hundred and fifty to three hundred annually.

The opportunity for increasing the output of finished cattle from the State will be mostly by increasing the number of farmers engaging in the industry, rather than by increasing the number of cattle fed by any one man. To do this there should be some detailed information disseminated concerning the incentives, opportunities and profits to be derived from the business.

ADVANTAGES AND DISADVANTAGES OF CATTLE FEEDING IN MARYLAND.

The experiences related by some men engaged in the business are very interesting, since they explain in a measure a few of the conditions which govern the extent of the enterprise. First, it may be said that a certain amount of profit must be assured, and since this profit is variable, due to the changing market prices, there is an element of speculation, which enters in and becomes quite sharp for the shrewdest of stockmen. The fear of not making a profit keeps many out of the business. Little training and skill in the methods and practices of feeding, so as to get the right kind of finish when prices are good, handicaps others. Then a certain amount of working capital must be in readiness to take advantage of bargains, and stem the tide of unfavorable prices for finished cattle. Because of the uncertainty connected with a part of the work, men with limited amounts of capital are finding other and surer investments.

There are tenant farmers who could and would feed cattle, if they had the capital to buy them. Some of these have co-operated with men who have cattle, and are looking for labor. Thus a system of feeding cattle on the shares is the result. Several reports speak favorable of such an arrangement. The management under such a system is for the tenant to raise and feed the grain and roughage, look after the farm and fences, and care for the stock, while the landowner has the land and livestock as capital to balance against the work of the tenant. Co-operation on the part of capital and labor, with an equal division of the profits, is proving as satisfactory to some farmers as it is in some other lines of business.

On most of the farms of the State there is more or less roughage to be utilized in some way or other. All the hay, straw and fodder do not find a ready sale. Manure is needed to build up the fertility of the soil. Therefore cattle feeding is a natural consequence. But it is not so much the utilization of the roughage as it is the making of manure for the farms that makes men consider most seriously the problems connected with the feeding of cattle. Men are realizing the importance of barnyard manure in crop production, especially on the lighter and sandy soil farms. Those who have tried the manure are fully convinced. They find manure puts life into the soil, and does for it what commercial fertilizers never can do. Fertilizers are good in their place, but the manure made from the feeding of cattle, and retained on the farms, is the cheapest and best of fertilizers.

Many troubles about fertilizers, costs of producing crops and labor are being solved by those who feed cattle.

In fact, cattle feeding utilizes the grain and roughage where the manure should be left, lessens the expense of hauling to and from the farm, and secures better and more competent labor by furnishing employment the entire year.

CHECKS ON THE EXTENT OF CATTLE FEEDING IN THE STATE.

While beef production is quite a large industry in the United States, there are a number of things which hold in check the progress and extent of the work in Maryland. First, there is a lack of good cattle for feeding. In this particular Maryland is not alone, for stock shippers report a heavy demand throughout the East for good cattle. The scarcity is quite perplexing. Conditions have changed in the ranching part of the country. So great has been the demand for homes, that the land has been settled up and divided into small holdings. This change in land ownership has decreased the amount of feeding cattle produced.

Moreover, to meet this scarcity of good cattle, it will be well for men who have the rough pasture land to deal more seriously with the problem of growing their own feeding stock. In other words, adopt the policy of many farmers of the Central Western States. Conditions in some sections are even more favorable here than there for the growing of beef from the calf to the block. A few have adopted such a plan, and are getting along quite successfully.

Another check to the extent of cattle feeding is the increased price of feed stuffs. Hay and grain of all sorts have a much higher market value than a few years ago.

The demand for dairy products, especially near the larger cities, commands marked attention. The supply of milk going into Washington, Baltimore and Philadelphia is truly great. Then the farmers having good railroad facilities to these markets find it very profitable to engage in dairying. And while this industry needs encouragement, and is growing and thriving, yet it cannot be said that dairying is always a success. The conditions sometimes favor another kind of enterprise, but on account of the attractive market quotations for dairy products. the feeding and growing of beef cattle receives very little consideration.

LABOR FOR THE FARM.

One of the most serious handicaps to cattle feeding in this State is the ever-present scarcity of good, competent and reliable farmer labor. A successful feeder should be a man that is able to do more than carry out feed to the stock, and clean out the stable. He should be a keen observer of the need of the animals in his care. It is, indeed, a grave misfortune that only a few of the right sort can be found. The negro who was once employed is going to the city. Factories of all sorts are calling for men. If labor was available, cattle feeding would increase, since there are men with good farms and ready capital to finance the enterprise. Almost everywhere much interest was manifested in the question of satisfactory labor.

DESIRABLE TYPE OF CATTLE.

The best type of feeder has a conformation which will allow the production of a maximum amount of the high-priced cuts of beef. The good feeding steers are those which are comparatively wide, round and deeply ribbed. The animal which is upstanding, light in the flank and shallow in heart girth seldom makes a good feeder.

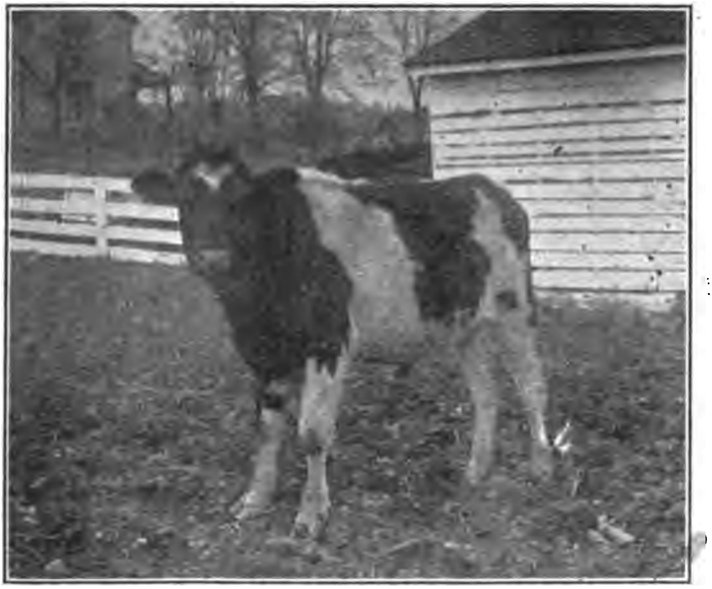

Figure 1—A Poor Feeder.

In form the feeder should be broad and deep in front, low set and blocky built; he should carry out strong and wide in the hind parts as well, and be deep and low in the flank and twist. The head is usually a condensed reflexion of the rest of the form. A broad, short head is associated with a thick, wide, low-set body, and the narrow head with slim face is generally accompanied with more narrowness and greater length of legs and body.

It will be found frequently that the narrow-chested animal is a poor feeder, which makes but little progress in proportion to the feed that it eats. The animal with the deep, wide chest on the bottom, and not shrinking away behind the forelegs, is one strong in vital force and constitution, and is not deficient in capacity to make feed into flesh and fat economically.

An important factor which enters into the value of the finished steer is quality; so as to have quality when fattened, the animal must have much of it before it goes into the feed lot. Quality in the steer means fine bone, soft, mellow hide, and fine, silky hair, while a very rough, heavy frame, coarse joints, prominent, ragged hips, and rough, open shoulders are such attributes which are the most striking evidences of deficiency in this feature. Quality has to do also with the meat and the distribution of fat. Meat of a good character is nicely marbled with fat—that is, the fat is well interspersed between the muscular fiber. Such meat has a richness and juiciness which is much sought after by the consumer. Now, furthermore, the finished steer, to have high quality, must have not only fine bone, a mellow hide, and fine, silky hair, but also a deep, even distribution of flesh, which is mellow and elastic to the touch. There should be no evidence of patchiness, either about the last ribs or the tail head, for such shows an uneven distribution of fat, which is undesirable.

THE KIND OF CATTLE FOUND ON MARYLAND FARMS.

Generally speaking, the kind of cattle found in the feed lots and pastures was not of the best type. So many cattle were lacking in width and depth of body, high standing from the ground, and very deficient in muscular development. Quite often there was a good bony frame, with sufficient quality, but there was not the large heart girth, with the full crops so much desired in all good feeders; the ribs were deficient in their width of arch, the loins were narrow, and, in fact, the hind quarters were light, narrow and wanting in the depth which is found with the low flank and deep twist.

Experience has taught but few Maryland men how to handle and fatten the well-bred and muscular steer. The chief demand all along has been for the thin steer at a low figure. This, of course, has helped to fix the type of steers going into the feed lot.

The type in many of the herds lack uniformity, for even in the small bunches several different types were found. In some feeding lots a few of the low-down blocky types were in with the others of the larger, heavier-framed sort. Uniformity in type, size, weight, and even color, in a herd of well-finished steers has immeasurable value, which should be duly recognized.

The weight most commonly desired, for a short feeding period, ranges closely around 1,000 pounds. Especially is this true for winter feeding, and when cattle are bought in November. If bought for summer grass feeding, or if bought in September for early winter feeding, a steer near the 800 to the 850 mark is bought.

Just recently a few men, by reason of the scarcity of the larger animals, have bought young calves. Not much attention is given to age and weight, if quality and prices are good. And again, it would be well that more attention to be given to quality and the proper type in conformation than to age and weight.

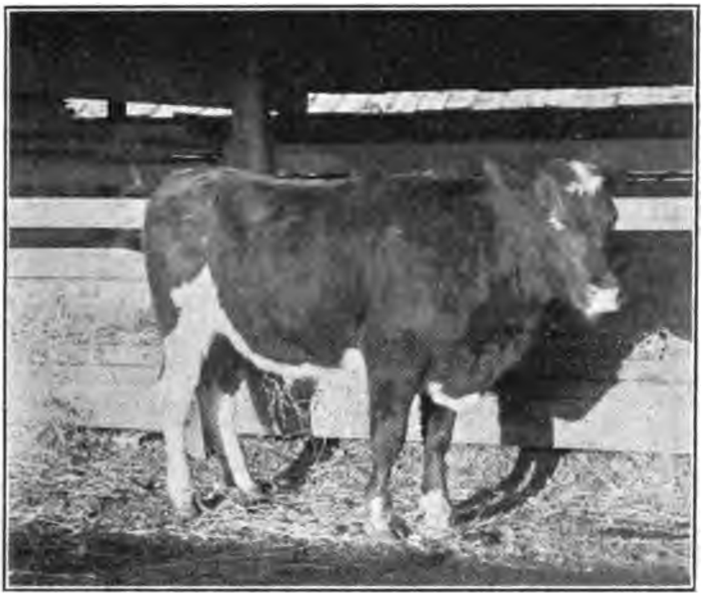

Figure 2—A Steer Fattened in Montgomery County, Md.

STEERS OF DIFFERENT BREEDS.

With the improved breeding of livestock, a most useful and profitable type of animal has been obtained for different purposes. Certain breeds of cattle have been bred, either for milk or beef production. Now for beef there are the Shorthorns, Herefords and Aberdeen Angus, which are the most generally known. These breeds have been developed especially for beef, and whenever a herd has much of the blood of either of these breeds in it, the type of the good feeder is generally found. Then aside from having a conformation peculiarly adapted for beef production, it is found that these breeds have different characteristics which feeders have learned to recognize and value highly.

As beef producers, the Shorthorns rank in the first class. In all the leading fat stock shows of Great Britain and America, Shorthorn steers far outnumber any other breed, while in the stockyards Shorthorn grades largely predominate.

Shorthorns are good lot and stall feeders; they make rapid gains, and show fairly good dressing percentage; they are a little inclined to be leggy and upstanding, which is against them, but they are quick to adapt themselves to any changes and environments.

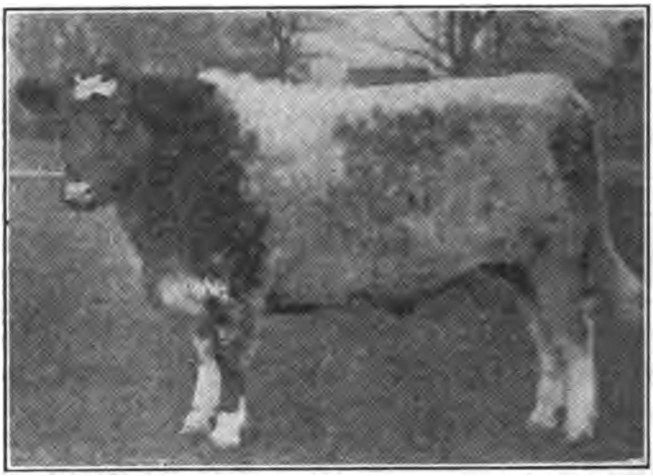

Figure 3—A Typical Shorthorn Steer.

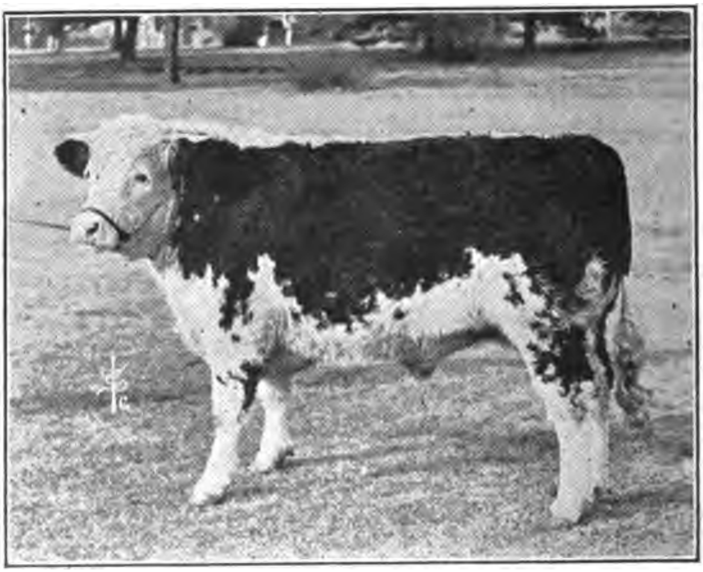

Figure 4—A Typical Hereford Steer.

The Herefords as meat producers have high rank. These cattle have made marked improvement within the last twenty-five years. The breed is criticized for having an excess of throatiness, dewlap and lack of development of rump and hind quarter. The Hereford steer is noted a· an excellent grazing animal, and in this respect has no equal. Herefords mature much more rapidly than Shorthorns, and are much in favor for the production of the so-called "baby beef."

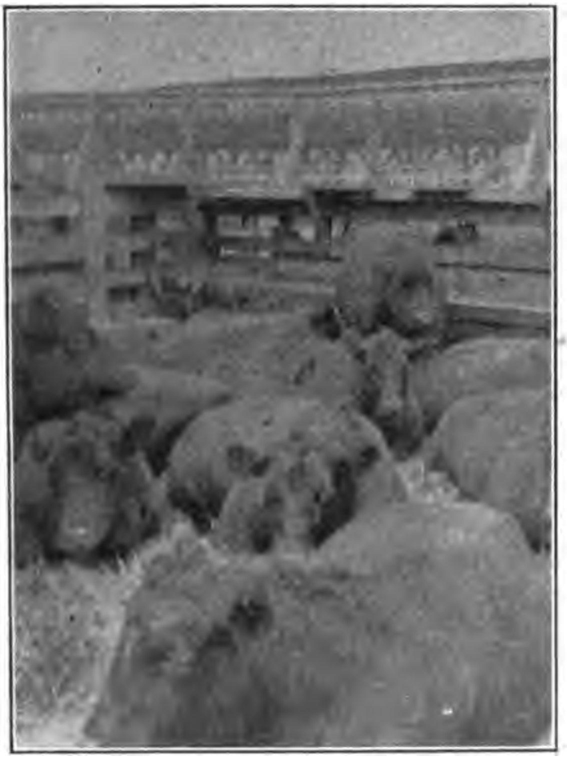

Figure 6—Kambrick's Car-load of Fat Steers (Aberdeen Angus) at Chicago Live-Stock Show, 1906. (Photo by Porter.)

In the show ring the Aberdeen Angus steer has made a remarkable record. No other breed has made so fine a record in winning the high honors at the Chicago International Livestock Show. The breed has won many highest honors, not only in champion fat steer classes, but also in carload lots. The steers are excellent feeders, but must not be too closely confined; they are more or less wild by nature, so that strangers and dogs must keep away. This breed appears to stand shipping by rail somewhat better than the other breeds of cattle. They are not so well adapted to the range as the Herefords, but mature early, and are highly prized by many growers of "baby beef."

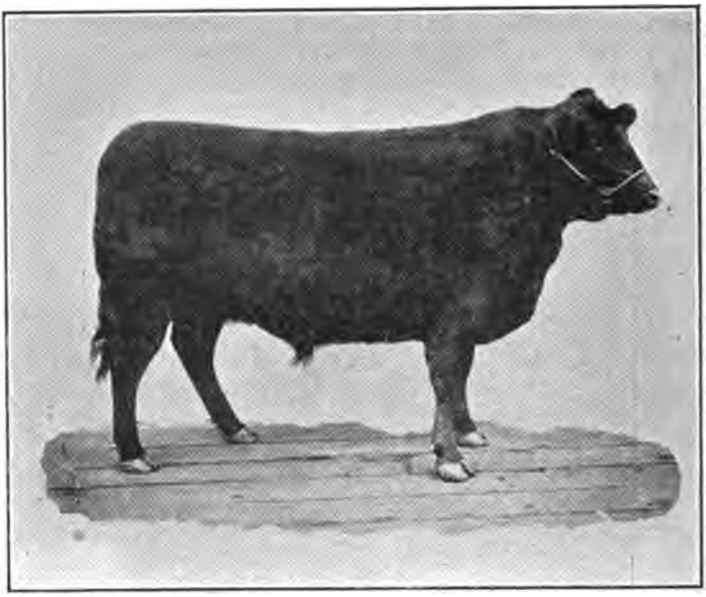

Figure 5—A Typical Aberdeen Angus Steer.

SOURCES OF SUPPLY.

Where to secure good high-quality feeding cattle at reasonable prices engages the attention of every stockman. Where to go is quite perplexing. The markets are searched everywhere to supply the demand, and as yet it cannot be said with much certainty that one market is at all times better than another. Doubtless, at stated seasons of the year one or more markets are better than others for some grades or classes of feeding stock.

The outlook for feeding cattle is very unsettled in some sections of the State, by reason of experience and reports which verify the statement that cattle from certain markets or districts are better feeders, and will finish easier than cattle from other parts. Such reports are always valuable, but when the supply of stock is limited, more than one market must be investigated. It always pays to keep in close touch with the larger markets, because as a usual thing a better quality of animal can be obtained there.

The supply of the two-year-old steer, so much in demand at the present day, is not so great as formerly. At the stockyards of the large markets of the west many of the two-year-olds are coming in as the finished product, and are ready for slaughter. If such a steer is there unfinished, and has quality and breeding, it is usually because his owner has been unfortunate in not having feed to finish him. The price of such stock is unusually high.

The greatest market for feeding cattle is Chicago. Other good markets which are patronized by Maryland feeders are Southwest Virginia, St. Louis, Kansas City, Buffalo and Pittsburg. Some cattle have been secured on the market at Lancaster, Pennsylvania.

Stock coming into the State are classified by many men not according to their condition or quality, but according to the section of country or market from which they have been shipped. Most of the cattle from the west are known as Western or Chicago cattle; others are known as Southwest Missouri or Texas cattle. Stock from the north are called either Buffalo or Canadian, and may acquire a new name, if they stop at Pittsburg or Lancaster, Pennsylvania. Then, cattle from Tennessee, Virginia and West Virginia are classed chiefly as Virginian cattle.

The subject of acclimation has been receiving much attention in connection with the source of supply. For short-winter feeding there is not so much preference noted, but when the cattle are to be pastured, particularly in the warmer counties of the State, it is to be expected that cattle grown in a similar climate will do best. This being so, it is natural that Virginian cattle will acclimate easiest in most parts of Maryland.

In some localities there has been a decided preference expressed for cattle coming either from the West, North or from Virginia.

When men are catering to a demand for a handy weight bullock the Virginia steer is put into the feed lot; he makes a smooth finish on light gains, and also finishes easily if kept on a summer pasture. Some claim that the market in Washington, Baltimore and Philadelphia for the handy weight bullock has been built up largely by the use of the Virginia steer. The feeders producing the heavy beef, and supplying some of the export trade, are obtained chiefly from the West and North. These cattle do not always acclimate easily, but often are the heavier gainers. It takes more than a little warming up to get him in shape for market; his frame has been built for a wealth of fat and flesh, and therefore takes more time than many of the speculative feeders care to give them.

Several parties who handle cattle in small bunches have expressed a great deal of dissatisfaction with the stock which they have ordered through commission firms. The quality of the animal was not what they expected; the weights were either too heavy or too light, or one or more animals were out of class with the rest.

Local commission men are an advantage many times; they will ship in several loads of cattle, and then allow the farmers to come and select their own feeders. At times a few men will agree to bear the expenses of one of their number, who is competent to select feeding cattle, to go and buy their cattle. But some men, who generally feed a large number, and are confident in making a saving, do their own buying, and also make their own sales.

Freight rates, distance from market and driftage each have an important bearing on the traffic and have their influence on the cost of transportation. When looking over the reports of farmers, it is difficult to make a comparison, since so much has been said about rate discrimination. Rates per hundred from Chicago to Baltimore have been 25 cents, from Buffalo to Baltimore 19 cents, from Chicago to points in Washington and Frederick counties 25 cents, and from Buffalo to Garrett county 17 cents. A few loads from Kansas City to Frederick county have come in at 21 cents per hundred. In a few instances it is very evident that distance does not count for so very much.

The driftage on the long hauls is by far the greatest. The amount may vary within wide limits, and is the result of the care the cattle receive, both before starting on the journey and while en route.

RANGE OF PRICES FOR CATTLE.

Cattle.

	Native Steers 1500–1800 pounds.	Native Steers 1200–1500 pounds.	Poor to Best Cows and Heifers.	Native Stockers and Feeders.	Texas and Western Steers.
Range, 1906...	4.75a 10.50	3.90a 17.00	2.40a 6.60	1.75a 5 10	2.90a 6.35
Range, 1905...	4.40a 8.65	3.00a 8.45	2.25a 6.80	1.50a 5.45	2.60a 5.25
Range, 1904...	4.35a 10.50	3.35a 12.25	2.00a 7.50	1.50a 5.50	2.40a 5.65
Range, 1903...	4.10a 7.35	3.35a 8.35	2.50a 5.50	1.50a 5.20	2.55a 5.10
Range, 1902...	4.25a 14.50	3.60a 9.00	3.35a 8.25	1.90a 6.00	2.55a 7.65
Range, 1901...	4.75a 9.30	3.60a 12.00	2.00a 8.00	1.65a 5.15	2.75a 5.75
Range, 1900...	4.70a 15.50	3.90a 11.00	1.75a 6.00	2.10a 5.25	3.00a 5.90
Range, 1899...	4.60a 8.50	4.00a 8.25	2.00a 6.85	2.50a 5.40	3.10a 6.75
Range, 1898...	4.10a 6.25	3.80a 6.15	2.00a 5.40	2.50a 5.40	3.15a 5.40
Range, 1897...	4.00a 6.00	3.35a 6.00	1.75a 5.40	2.40a 4.75	2.75a 4.90
Range, 1896...	3.40a 6.50	2.90a 6.25	1.75a 4.40	2.20a 4.10	2.10a 5.50
Range, 1895...	3.60a 6.60	2.90a 6.40	2.00a 5.75	2.25a 5.15	2.25a 5.75

Valuation Cattle, 1906	$163,670,389.00
Valuation Calves, 1906	4,520,130.00

SYSTEMS OF FEEDING.

The system or method of getting cattle ready for market varies in some particular in nearly every section of the State. Climate conditions, and the varied character of the soil, its topography and adaptability for certain crops, and field management, make it advisable to pursue different methods.

The system of feeding cattle, though varying as to minor details, may be divided into two classes, namely, the short feed and long feed. In the short feed the cattle are put on a full grain ration as soon as possible, and are kept only for a short time, usually from three to six months. In the long feed the cattle are kept on rough feed, with very little grain during the first winter, pastured during the summer, and finally sold from the grass in the fall, or put on a grain ration and sold in the winter. The length of time given to a long feed is generally about twelve or more months.

SHORT FEEDING.

Many of the cattlemen in Maryland follow the short feeding system. In truth, most of the cattle sent to market from the feeding lots have been put through on a short feed. This is naturally to be expected, because very much of the land is cropped each season. Then, in order to feed up the roughage, and make manure, cattle are fed during the winter months.

This system of short feeding naturally divides itself into three heads: First, grass; second, stall or lot, and third, grass and stall in combination.

In the western part of the State, especially in Harford county, a few men who have much rough pasture land buy their cattle in the early spring, and make use, if need be, of a little corn-fodder, or other roughage, until grass comes. The cattle are then turned out to pasture, and fattened on the grass as best they will, without any grain. With good grass this method has been reported to make fairly good rent for the kind of land used. When grain was fed to the cattle on grass the gains and prices did not compensate the expense incurred.

Most of the cattle fattened in Maryland are fed in stalls, open stables and sheds, with an adjoining lot or pound. Most of the stall feeding is carried on during the winter months. The feeding is commenced in November, or the first of December, and the cattle are finished between April 1 and the first of June. Some bunches are in such a condition that they can be finished, ready for market, in 60 to 90 days.

The grass and stall in combination feeding commences usually in September, and the cattle are finished by Christmas or the first of January. In this way the cattle get filled up, recover from the loss in driftage, and make some gain on the fall pastures before the grain feeding commences.

LONG FEEDING.

Only a small per cent. of the cattle feeders of the State keep cattle feeding as long as a year. This class of feeders are found chiefly in Montgomery, Howard and Harford counties, while those who raise their own cattle are found in Garrett, Washington and Talbot counties.

Under this system the cattle are pastured through the summer months. The pastures in the sections which follow this system are permanent in character, and the growth consists mainly of Kentucky blue grass and white clover. These pastures are located on the meadow lands, and on the hill lands that are too rough to cultivate. In many cases they have never been plowed, and in most cases have been in grass many years. In the mountain sections cattle are grazed on lands which are growing timber, with much undergrowth of brush.

The class or grade of cattle used for long feeding differs from those used for short feeding chiefly in their weight. The long-feeding period cattle go into the lot about 100 to 200 pounds lighter than for the short period. In each case the same quality breeding and conformation is desired. Cattle fed for a year or more make considerably greater total gains than the short term feeders. As much as five hundred pounds have been reported in a few instances.

SHELTER FOR CATTLE.

The shelter problem in cattle feeding is of importance, since it influences materially the cost of labor and other questions which effect the cost of producing beef. Cattle should be protected during unfavorable seasons of the year, but the question is what is necessary and sufficient to give the animal comfort, and yet not overdo the thing? Too warm quarters are just as harmful to the health, and to the rate of gains, as not warm enough. There should be, however, sufficient protection, so that the animal will not need to use much more food for heat production to keep up the normal temperature of the body than is naturally radiated during the rapid assimilation of food. The animal, after having been fed for beef for some time, has more or less fat distributed over the body just beneath the skin, and this gives added protection. But, when providing shelter, the animal must not be given uncomfortably warm quarters, because he will lose appetite, become languid and lose weight. Quarters for fattening cattle should be dry and well ventilated, rather than very warm.

For stock cattle the situation is different. They are not forced along with grain, and hence do not have a cover of fat as a protection. Director Waters, of the Missouri Experiment Station, after studying the shelter problem for several years, concludes from experiments that cattle living on rough feed and little grain must have a good, warm, well-ventilated barn, and that fattening cattle do best in open sheds. The Pennsylvania Station† has also done some valuable work on the subject of sheltering and feeding cattle, from which they concluded after three years' work that the gains made by fattening steers are not increased by warm quarters. Stables cannot be too cold for fattening steers, provided they are kept dry and well bedded.

BUILDINGS AND BARNS USED IN FEEDING CATTLE.

The character of the barns and sheds for feeding cattle varies considerably in different parts of the State. The climate of the western counties has caused farmers to construct large bank barns for the sheltering of their crops and livestock, while farmers in Southern Maryland, and on the Eastern Shore, have built less expensive structures. Simple sheds have sufficed quite well. The open shed for fattening cattle is found in many places, and, all things considered, is the best when cattle are fattening and taking on heavy and rapid gains. At one place a small feeding lot entirely shedded over was found. Some straw sheds are in use, and quite a little shelter is furnished by stacking the straw in the feed lot about the barn.

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†Bulletin No. 74 of the Pennsylvania State College Experiment Station.

Few barns and little shedding are used during the summer months for beef cattle, but in the winter most of the feeding is done within barns. Some of these barns are fitted up with stalls and stanchions, in which each animal is fastened for the night at least. Others have small enclosures, in which a number of steers are limited as to space, and not allowed to move about with much freedom.

It is quite evident that the amount of shedding and barn shelter required for fattening cattle is not definitely determined or well understood, because it is a frequent occurrence to find expensive large barns in localities where open sheds would have answered sufficiently well. When the weather is warm and mild it is far better for the stock to be outside than housed up in a damp, dark barn.

HANDLING AT STABLE.

There are several methods in use for handling cattle about the stable. One is to keep the cattle in the barn over night, and then allow them to run on an outside lot during the day, if the weather permits. Another practice is to keep the cattle fastened in the barn all the time, except for a short time when the stable is cleaned. And still another practice is simply to fasten the cattle while they eat their grains; the rest of the time they are given the run of a small lot or pound, and open shed. The stables of the first two methods have the manure removed daily, which of course necessitates much daily labor. In the last method there is no stable to clean. The place is kept clean by liberal applications of straw, or the waste from shredded fodder.

When handling cattle about a barn it is a mistake to keep them fastened in lock stanchions any length of time. A steer to do his best must have some freedom and exercise. At the same time precautions must be taken lest the lot or stable be too large, so that the exercise is excessive, and thus the food consumed is used in energy, instead of producing flesh and fat. The least expenditure of energy for maintenance occurs when the steer is lying down comfortably; consequently the quarters should be provided for this necessity. Feed steers plentifully; give them a good, dry, soft bed, and they will lie down, stretch out to the feeder's delight, be content, and make rapid and substantial gains. Comfort and contentment are little thought of by those who allow the pound or lot to become so filthy that the steer will not lie down. A constant supply of good, clean water, and plenty of salt always within reach, also contribute to the steer's comfort, and increase the farmer's returns.

FOLLOWING CATTLE WITH HOGS.

Keeping hogs in the feed lot, stable or pasture, to follow after cattle, is not a general practice in Maryland. The few men who have kept hogs in this way give very favorable reports. One instance shows that a good share of the profit of the feeding was made by the hogs. This feeder reported between eight and nine dollars for each hog on eighteen head, which had followed twenty-four steers. The number of hogs per head of cattle depends pretty much on the character of the feed given. When the grain was ground into meal, or when the corn was fed in silage only about one hog for every four to six steers was kept, but with crushed corn or corn-fodder one hog followed two or three steers. A few hogs in a pasture will work over the droppings of the cattle, and prevent the rank growth in spots which cattle will not eat.

PASTURING CATTLE.

Beef cattle which are carried through the summer are mostly fed on pastures.

The permanent pastures are mostly composed of Kentucky blue grass and white clover. In some sections the white clover does not flourish as well as in others. When white clover is absent the farmers do not regard the pastures as highly, as they have noted that cattle do not do as well as when on the pastures containing clover. Red top grass is found to some extent in many pastures, particularly in the Southern and Eastern part of the State.

On the lighter lands of Southern and Eastern Maryland the Bermuda grass is found widely distributed, and makes a good pasture.

The Japan clover (Lespedeza Striata) is found wild in the pastures in many parts of the State. It is quite nutritious, and is especially valuable as a mid-summer pasture.

The marshes and land along the rivers and creeks in the tidewater sections grow an abundance of coarse natural grasses, as do also the glades in the mountains of Western Maryland. These grasses produce good early and late pastures, and also a fairly good hay, if cut at the proper season. Meadows and land which has been cut for hay and wheat stubble afford considerable late summer and fall pastures. In sections where fodder is topped the part that remains in the field gives fall and winter pasture.

The quality of the pasture varies considerably with the soil, and the way in which it has been cared for. The best natural pastures are found in the Northern and Western parts of the State. In these sections woodland or land which has just been cleared, if grazed, will soon become set with grass and clover, and in a few years have a good sod, which will afford lots of feed. Some farmers give their pasture lands good care, and look after the keeping down of obnoxious weeds. In a few instances farmers give the pasture lands occasional top dressings of lime, manure or fertilizer, and find that such treatments pay well. This practice should be more general.

Pastures should not be grazed too closely in the fall, but a slight growth allowed to accumulate to serve as a mulch for winter protection, and this will also induce an earlier start the next spring.

The amount of feed produced per acre, and consequently the area required for an animal, varies considerably with the seasons and the condition of the soil. Some pastures will summer one steer per acre, while other pastures will require two to four acres per steer.

The length of the pasturing season varies in different parts of the State, and also with the weather conditions from six to nine months. The duration of life of a pasture varies with the soil conditions, and the treatment to which it has been subjected. There are many pastures in the State ranging from 30 to 100 years old; but usually land is left in pasture only three to five years.

Usually it would pay farmers to make a greater effort to get good, permanent pastures established, and then take good care of them, so as to get them to last a great many years, rather than to be continually trying to get them.

SUPPLEMENTING PASTURES BY GRAIN OR OTHER FEED.

As a rule cattle are fed nothing else when on pasture; yet some farmers have found that the feeding of some grain, daily, will pay. Some feeders give some silage or soiling to cattle during the part of the season when the pasture becomes short.

Cattle which are sold to the butchers directly from the pastures are usually fed some grain during the two or three weeks just previous to shipment.

Some stockmen claim that it requires just about so much grain to finish cattle for market, and that if this is given gradually a little grain daily, all through the season, they are in better condition to go on to grain feeding in the fall.

GAINS MADE ON PASTURE.

The gains made on pasture are usually very satisfactory, and will average better than those made by stall feeding. One man reported that a lot of steers which had been wintered on sweet corn fodder made a gain of three pounds per day on the pasture. This was an exceptionally good pasture, and returned to its owner from $1.65 to $4.00 net per month on each bullock.

Cattle wintered on silage will not gain as fast when turned on to grass as those fed on dry feed, but the silage-fed steers come through the winter better than those on dry feed.

FEEDS USED.

Grains.

The great feed for fattening cattle is corn. The grain and forage of this widely grown farm product is fed in many ways to stock, and only in a few instances are cattle put on the market without having had some corn. Where oats is grown in the crop rotation they are fed ground up with corn into what is called mixed feed. Very little wheat or rye is ever fed.

In making up rations for cattle, corn is often fed alone, but this system is not so popular at present, and small amounts of commercial feeds are used. Bran is used only in conjunction with corn meal. Formerly cottonseed had a place, but now, on account of its high price, most men have abandoned its use almost entirely, except to put on the market finish. One or two stockmen were giving a rather heavy ration of cottonseed meal with corn silage. Another man was using dried brewer's rye grains, which contained 19 per cent. of protein and five per cent. fat. These were shipped to his station for $15 per ton.

While some corn is bought by feeders who do not raise enough on their own farms, yet bran and cottonseed meal have the largest sales as feedstuffs.

ROUGHAGE.

The objects in feeding having been to make use of the rough forage there is little, if any, bought for the feed lot. Corn fodder and corn stover are the principal stuffs that cannot be easily sold, and must necessarily be fed up and made into manure. These with timothy hay, clover, alfalfa, silage, either of corn, sorghum or pea vines, and the straw from oats, wheat and rye, make up most of the available roughage. Timothy hay, oat, straw and corn fodder constitute the bulk of the roughage in Garrett and Washington counties. In Frederick and Carroll counties a wider variety is found. Here the pea vines left from the canning factories are made into silage. In Southern Maryland, and on the Eastern Shore, cow-pea hay and cow-pea pastures are found in quite extensive use.

The farmers of Maryland can grow quite a variety of legumes, and through them grow considerable of the protein which they require for balancing rations, and thus save the purchasing of the expensive by-product mill-feed.

SILAGE.

The success attending the use of silage in the dairy business has created much interest among beef-cattle men. Silage furnishes a succulent food, which is quite essential to the dairy cow in keeping her digestive system in good condition. The same will be found true for the beef animal. Twenty pounds of silage per day will supply all the bulk and water needed in a fattening ration. The other roughage may consist of either long fodder or mixed hay. The economy of using silage for fattening purposes is well brought out by Prof. A. M. Soule, at the Virginia Station, in Bulletin No. 157, in which he states the following conclusions:

"There was a difference of from .3 to .5 of a pound of gain per head per day in favor of the silage-fed cattle. They also finished out better, and in any discriminating market would certainly bring a better price than the dry-fed cattle.

"Of the three forms of roughage fed, the silage was eaten with the greatest relish, and there was absolutely no loss, whereas with the stover the loss amounted to 13.5 per cent., and with hay 4.16 per cent. Where a larger number of animals are fed this would make a considerable difference in the cost of ration, except that the shredded stover can be utilized to advantage for bedding."

Silage as it is put up today is better than when the practice was first started. Good silage of corn is made when the grain has passed the milk stage, and has commenced to glaze a little. Silage is made also from sorghum, corn and cow-peas and pea vines.

CORN STOVER.

Corn stover is used both shredded and unshredded. Ordinarily the cattle will waste a considerable quantity, whichever way it is fed. The shredded fodder is prepared because the cattle eat a greater percentage of it, and the manure is handled more easily. Fodder is often fed on the ground in the open pasture field to save the hauling of manure.

There is a saving, however, in having the fodder shredded. Usually the feed is taken care of earlier, and there is less exposure to leaching rains and weathering processes. Again, more feed can be put in a smaller space, thus requiring less storage space.

GAINS OBTAINED.

The amount of gain in weight varies with the length of the feeding period, the class of cattle and the ration given. Seldom is there less than 200 pounds gain, and sometimes as much as 400 or 500 pounds are obtained. A few who make a specialty of supplying the handy weight butcher trade simply put on enough weight and finish needed to make the animal sell well. Such light gains are made on those feeders which are smoothly turned, and are not especially well built for heavy gains. This class of steers go into the feed-lot in fair condition. Those stockmen who put on the heavy gains take cattle with all the quality possible, and pay particular attention to the beef type conformation. High quality feeding cattle, with good conformation, are bought at a high price in any market, but when such stuff is finished with a gain of 400 to 500 pounds it very easily goes to the export trade, which will quite often pay for the extra care of selection, together with high-class feeding.

HEAVY CATTLE.

The heavier cattle carry a higher degree of ripeness, and therefore have reached more nearly the best finish which is possible to give them. Some of these heavyweight cattle were receiving two or three pounds of cottonseed meal at the last to put on the finishing touches. The muscular fiber of the heavyweight steers is better developed; the feeding has been on a narrower ration and the quality of the meat produced draws buyers, with good prices, whereas the animals with light gains have not the same quality of meat, and therefore command lower prices.

The light gains and little finish are usually made when there is a rush to reach a rising market. Unfinished cattle are found in the stockyards partly because men are so eager to make, and fearful of losing, and partly because the stockman or feeder has not been skilled in the choice of foodstuffs which will give the desirable finish to suit the highest class trade.

THE WOLFF-LEHMAN FEEDING STANDARDS.

ANNUAL.	PER DAY PER 1000 POUNDS LIVE WEIGHT.					
	DIGESTIBLE NUTRIENTS.					
	Dry Matter.	Protein	Carbo-Hydrates.	Fat.	Total.	Nutritive Ratio.
Growing Cattle.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
2 to 3 mo. weighing about 160 lbs.	23	4.2	13.0	2.0	19.2	1:4.17
3 to 6 mo. weighing about 330 lbs.	24	3.5	12.8	1.5	17.8	1:4.62
6 to 12 mo. weighing about 350 lbs.	25	2.5	13.2	0.7	16.4	1:5.91
12 to 18 mo. weighing about 750 lbs.	24	2.0	12.5	0.5	15.0	1:6.81
18 to 24 mo. weighing about 950 lbs.	24	1.8	12.0	0.4	14.2	1:7.17
Fattening Cattle.						
First Period	30	2.5	15.0	0.5	18.0	1:6.45
Second Period	30	3.0	14.5	0.7	18.2	1:5.36
Third Period	26	2.7	15.0	0.7	18.4	1:6.14

The table gives a list of the most common feeding stuffs for fattening cattle in the State of Maryland. The computations are based upon the table of "Average Digestible Nutrients in American Feeding Stuffs," given in Prof. W. A. Henry's book, "Feeds and Feeding." The aim has been to facilitate the computation of rations, and to present figures in such simple form that no feeder will have difficulty in making up a ration according to the standards given from the material he has available on his farm.

Column one is headed "dry matter," and there is the digestible nutrients, which are divided into four separate columns. The first is "protein," second "carbohydrates," third "fats" and fourth the total. The last column gives the nutritive ratio.* In each of the columns is given the computations of the various food stuffs from one pound up to the amount that is likely to be used in compunding a ration.

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*The proportion of digestibie nitrogenous food (protein) to the non nitrogenous (carbohydrates plus fat).

KIND AND AMOUNT OF FEED.	Dry Matter.	DIGESTIBLE NUTRIENTS.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total.	
Red Clover Hay, 1 lb.	.847	.068	.358	.017	.443	1:5.8
" " " 3 "	2.541	.204	1.074	.051	1.329	
" " " 5 "	4.235	.034	1.790	.85	2.215	
" " " 8 "	6.776	.544	2.864	.136	3.544	
" " " 9 "	7.623	.612	3.222	.153	3.987	
" " " 12 "	10.164	.816	4.296	.204	5.316	
" " " 15 "	12.705	1.020	5.370	.255	6.675	
" " " 18 "	15.246	1.228	6.444	.306	7.974	
" " " 20 "	16.940	1.360	7.160	.340	8.860	
Alfaffa Hay.....1 lb.	.916	.11	.396	.012	.518	1:3.8
" " .....3 "	2.748	.33	1.188	.036	1.554	
" " .....5 "	4.580	.55	1.980	.060	2.590	
" " .....8 "	7.328	.88	3.168	.096	4.144	
" " .....9 "	8.244	.99	3.564	.108	4.662	
" " ....12 "	10.992	1.32	4.752	.144	6.216	
" " ....15 "	13.740	1.65	5.940	.180	7.770	
" " ....18 "	16.488	1.98	7.128	.216	9.324	
" " ....20 "	18.320	2.20	7.920	.240	10.360	
Corn Fodder.....1 lb.	.578	.025	.346	.012	.383	1:149
" " .....3 "	1.734	.075	1.038	.036	1.149	
" " .....5 "	2.890	.125	1.730	.060	1.915	
" " .....8 "	4.624	.200	2.768	.096	3.064	
" " .....9 "	5.202	.225	3.114	.108	3.447	
" " ....12 "	6.936	.300	4.152	.144	4.596	
" " ....15 "	8.670	.375	5.190	.180	6.894	
" " ....18 "	10.404	.450	6.228	.216	6.894	
" " ....20 "	11.560	.500	6.920	.240	7.660	
Corn Silage.....1 lb.	.21	.009	.113	.007	.129	1:14
" " .....5 "	1.05	.045	.565	.035	.645	
" " ....15 "	3.15	.135	1.695	.105	1.935	
" " ....20 "	4.20	.180	2.180	.140	2.580	
" " ....25 "	5.25	.225	2.825	.175	3.225	
" " ....30 "	6.30	.270	3.390	.210	3.870	
" " ....35 "	7.35	.315	3.955	.245	4.615	
" " ....40 "	8.40	.360	6.360	.280	3.160	
Corn Stover.....1 lb.	.60	.017	.324	.007	.338	1:20
" " .....5 "	3.00	.085	1.620	.035	1.690	
" " .....8 "	4.80	.136	2.592	.056	2.704	
" " ....12 "	7.20	.204	3.888	.084	4.056	
" " ....15 "	9.00	.255	4.860	.105	5.070	
" " ....18 "	10.80	.306	5.832	.126	6.084	
" " ....20 "	12.00	.340	6.480	.140	7.760	
Corn (Av.)......1 lb.	.89	.079	.667	.043	.789	1:9.7
" " ......2 "	1.78	.158	1.334	.086	1.578	
" " ......3 "	2.67	.237	2.001	.129	2.367	
" " ......4 "	2.67	.316	2.668	.172	3.156	
" " ......5 "	4.45	.399	3.335	.215	3.945	
" " ......6 "	5.34	.477	4.002	.258	4.734	
" " ......7 "	6.23	.553	4.669	.301	5.522	
" " ......8 "	7.12	.612	5.336	.344	6.312	
" " ......9 "	9.01	.711	6.003	.387	7.101	
Corn and Cob Meal 1 lb	.849	.044	.60	.029	.673	1:15.2
" " " 2 "	1.698	.088	1.20	.058	1.346	
" " " 3 "	2.547	.176	1.80	.087	2.019	

KIND AND AMOUNT OF FEED.	Dry Matter.	DIGESTIBLE NUTRIENTS.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total.	
Corn and Cob Meal 4 lb	3.396	.176	2.40	.116	2.692	
“ “ “ 5 “	4.245	.220	3.00	.145	3.365	
“ “ “ 6 “	5.094	.264	3.60	.174	4.058	
“ “ “ 7 “	5.943	.308	4.20	.203	4.711	
“ “ “ 8 “	6.792	.352	4.80	.232	5.384	
“ “ “ 9 “	7.641	.396	5.40	.261	6.057	
Barley ....1 lb.	.891	.087	.656	.016	.759	1:7.8
“ ....2 “	1.782	.174	1.312	.032	1.518	
“ ....3 “	2.673	.261	1.968	.048	2.277	
“ ....4 “	3.567	.348	2.624	.064	3.036	
“ ....5 “	4.455	.435	3.280	.080	3.795	
“ ....6 “	5.346	.522	3.936	.096	4.554	
“ ....7 “	6.237	.609	4.592	.112	5.313	
“ ....8 “	7.128	.696	5.248	.128	6.072	
“ ....9 “	8.019	.783	5.904	.144	6.813	
Oats............1 lb.	.89	.092	.473	.042	.607	1:6.2
“ ....2 “	1.78	.184	.946	.084	1.214	
“ ....3 “	2.67	.276	1.419	.126	1.821	
“ ....4 “	3.56	.368	1.892	.168	2.428	
“ ....5 “	4.45	.460	2.365	.210	3.035	
“ ....6 “	5.34	.562	2.838	.252	3.642	
“ ....7 “	6.23	.654	3.311	.294	4.249	
“ ....8 “	7.12	.746	3.784	.336	4.856	
“ ....9 “	8.01	.838	4.257	.378	5.463	
Wheat Bran.....1 lb.	.88	.12	.39	.027	.537	1:3.7
“ “ ....2 “	1.76	.24	.78	.054	1.074	
“ “ ....3 “	2.64	.36	1.17	.081	1.611	
“ “ ....4 “	3.52	.48	1.56	.108	2.148	
“ “ ....5 “	4.40	.60	1.95	.137	2.685	
“ “ ....6 “	5.28	.72	2.34	.162	2.222	
“ “ ....7 “	6.16	.84	2.73	.189	3.759	
“ “ ....8 “	7.04	.96	3.12	.216	4.296	
“ “ ....9 “	7.92	.108	3.51	.243	4.833	
Brewers Gr., dry 1 lb.	.918	.157	.363	.051	.571	1:3
“ “ “ 2 “	1.836	.314	.726	.102	1.142	
“ “ “ 3 “	2.754	.471	1.089	.153	1.713	
“ “ “ 4 “	3.672	.628	1.452	.204	2.284	
“ “ “ 5 “	4.590	.785	1.815	.255	2.855	
“ “ “ 6 “	5.508	.942	2.178	.306	3.426	
“ “ “ 7 “	6.426	1.099	2.541	.357	3.997	
“ “ “ 8 “	7.344	1.256	3.904	.408	4.568	
“ “ “ 9 “	8.262	1.413	3.267	.459	5.139	
Gluten Meal.....1 lb.	.918	.258	.433	.11	.801	1:2.7
“ “ .....2 “	1.836	.516	.866	.22	1.602	
“ “ .....3 “	2.754	.774	1.299	.33	2.403	
“ “ .....4 “	3.672	1.032	1.732	.44	3.204	
“ “ .....5 “	4.590	1.290	2.165	.55	4.005	
“ “ .....6 “	5.508	1.548	2.598	.66	4.806	
“ “ .....7 “	6.426	1.806	3.031	.77	5.607	
“ “ .....8 “	7.344	2.064	3.464	.88	6.408	
“ “ .....9 “	8.262	2.322	4.697	.99	7.209	
Linseed Meal O.P. 1 lb	.908	.293	.327	.007	.627	1:1.2
“ “ “ 2 “	1.816	.586	.654	.014	1.254	
“ “ “ 3 “	2.724	.879	.981	.021	1.881	

KIND AND AMOUNT OF FEED.	Dry Matter.	DIGESTIBLE NUTRIENTS.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total.	
Linseed Meal O.P. 5 lb	4.540	1.465	1.634	.035	3.135	
" " " 6 "	5.448	1.758	1.962	.042	3.762	
" " " 7 "	6.356	2.051	2.289	.049	4.389	
" " " 8 "	7.264	2.344	2.616	.056	5.016	
" " " 9 "	8.172	2.637	2.943	.063	5.643	
Cottonseed Meal 1 lb.	.918	.372	.169	.122	.663	1:1.24
" " 2 "	1.836	.744	.338	.244	1.326	
" " 3 "	2.754	1.116	.507	.488	1.989	
" " 4 "	3.672	1.488	.676	.610	1.652	
" " 5 "	4.590	1.860	.845	.732	2.315	
" " 6 "	5.508	2.232	1.014	.854	2.978	
" " 7 "	6.426	2.604	1.183	.976	3.641	
" " 8 "	7.344	2.976	1.352	1.098	4.304	
" " 9 "	8.262	2.348	1.521	1.120	4.967	
Hominy Chop....1 lb.	.889	.075	.552	.068	.695	1:9.5
" " ....2 "	1.778	.150	1.104	.136	1.390	
" " ....3 "	2.667	.225	1.656	.204	2.185	
" " ....4 "	3.556	.300	2.108	.272	2.880	
" " ....5 "	4.445	.375	2.660	.340	3.575	
" " ....6 "	5.334	.450	3.212	.408	4.270	
" " ....8 "	6.223	.525	3.764	.476	4.965	
" " ....9 "	7.112	.600	4.316	.544	5.650	
" " " 4 "	3.632	1.172	1.308	.028	2.508	

RATION COMPARED WITH STANDARD.

After studying the methods of handling cattle, as done by the most successful feeders, it will be interesting to note some of the daily rations given to animals which are not fattened on grass. The following rations are fairly representative of the prevailing methods of feeding throughout the State.

Farm No. 1—On this farm, located in Montgomery county, cattle weighing about 850 to 900 pounds are bought usually about the first of November. The first winter these cattle are kept over on long corn fodder, and sometimes a little corn meal. The following summer grass constitutes the feed until corn is ready to feed in the fall. They are then taken up and grained on a ration of ground corn and bran, and finished in time for the early winter market. The past winter a herd of grade Shorthorn steers, which averaged about 950 pounds, were receiving a daily ration of about 30 pounds of silage, a peck of corn meal and bran mixed in equal parts by measure, with what long corn stover they cared to eat. These cattle were being prepared for the June market. The amount of mixed grain was to be increased as feeding progressed. Calculating out the food constituents furnished by this ration we have the following results:

FARM NUMBER I.

KIND AND AMOUNT OF FEED USED.	Dry Matter.	DIGESTIBLE NUTRIENTS.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total.	
	lbs.	lbs.	lbs.	lbs.	lbs.	
Silage 30 lbs.................	6.30	.270	3.39	.210	3.870	
Corn Stover 10 lbs...........	6.00	.17	3.24	.07	7.76	
Corn 5 lbs.....................	4.45	.399	3.335	.215	3.945	
Bran 5 lbs.....................	4.40	.60	1.95	.137	2.685	
	21.15	2.5	11.915	.632	14.380	1:10
Standard Ration	30.00	2.5	14.5	.7	18.2	1:5.36

Comparing the above ration with the standard, it is found faulty in that it does not furnish enough protein, and hence the nutritive ratio is too wide. Now this deficiency could be remedied easily and cheaply by alfalfa hay. The alfalfa being narrow in nutritive ratio should replace the bran, and a part of the stover, which is coarser, less palatable and wider in nutritive ratio.

Farm No. 2—This farm in Harford county is located in the grass region, and on it two or more lots of cattle are handled annually. The cattle which go through on grass are seldom given any grain before they go to market. The other lot is fattened the first winter on a ration consisting of 35 pounds of silage, 5 pounds of stover, 8 pounds of corn and cob meal and 2 pounds of cottonseed meal. The cattle receiving this ration, although they were to be sold in a few days, were looking rough, and did not show proper finish. A change of one pound of crushed corn for one of cottonseed meal would have been far better for the cattle. The nutritive ratio would be 1 :69, instead of 1 :9. Some clover hay in place of some of the corn stover would have been well, because the stover is coarse, and not so palatable. The nutritive ration of clover is 1 :5.8, and corn stover is 1 :20.

KIND AND AMOUNT OF FOOD.	DRY MATTER.	DIGESTIBLE NUTRIENTS.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total.	
Silage 35 lbs.........	7.35	.315	3.955	.245	4.615	
Corn Stover 5 lbs....	3.00	.085	1.620	.0773	1.794	
CornandCob Meal8lbs	6.792	.352	4.80	.232	5.384	
Cottonseed Meal 2lbs	1·836	.744	.338	.244	1.326	
	18.978	1.496	10.713	.672	14.805	1:9
Standard...........	2.6	2.7	15.0	0.7	184.	1:6.14

Farm No. 3—In the western part of Baltimore county there is a farm on which some two or three hundred head of cattle are fattened annually. Some are fattened on grass, with a little grain at times. The largest number, however, is finished in the lot on a ration of thirty pounds of silage, mixed hay mostly clover, eight pounds, and about ten pounds of grain, which consisted of three pounds bran and seven pounds corn and cob-meal.

KIND AND AMOUNT OF FOOD.	Dry Matter.	DIGESTIBLE NUTRIENTS.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total.	
	lbs.	lbs.	lbs.	lbs.	lbs.	
Silage 35 lbs..................	7.35	.375	3.955	.245	4.615	
Mixed Hay 8 lbs.............	6.418	.444	3.054	.128	3.626	
Corn and Cob Meal 7 lbs......	5.943	.308	4.20	.203	4.711	
Bran 3 lbs.....................	2.64	.36	1.17	.081	1.611	
Total..........................	22.351	1.487	12.379	.658	14.564	1:9.2
Standard......................	26.	2.7	15.	.7	18.4	1:6.14

All the feed stuff going into this ration, except the bran, was raised on the man's own farm. The cattle going off this farm seldom made heavy gains while feeding, because just as soon as the steer has smoothed over he was sent in to Baltimore as a handy weight butcher bullock. In this rapid forcing process of fattening to make the ration narrower would increase its cost. A change from seven pounds of corn and cob meal to five pounds of corn would narrow the ration, and be better, because there is already plenty of roughage furnished by the hay and silage.

Farm No. 4—Again, at a farm near Reisterstown, in the same county as farm No. 3, a ration consisting of silage, long fodder and cottonseed meal was used. By skilful management the steers were taught to eat a daily ration of 11 pounds of cottonseed meal, with 35 pounds of silage, and approximately 10 pounds of stover.

KIND AND AMOUNT OF FOOD.	Dry Matter.	DIGESTIBLE NUTRIENTS.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total.	
	lbs.	lbs.	lbs.	lbs.	lbs.	
Corn Silage 35 lbs...	7.35	.315	3.955	.245	4.615	
Corn Stover 10 lbs...	6.00	.17	6.48	.07	7.76	
Cottonseed Meal 11 lb	10.098	3.092	1.859	1.364	6.293	
Total.................	23.448	3.577	9.054	1.679	14.788	1:4.4
Standard...........	26.	2.7	15.	.7	18.4	1:614

This ration contained more cottonseed meal than any other found among the feeders of beef animals, and moreover, it is too expensive when cottonseed is bringing $32 per ton on the market. A more liberal use of corn, which is the cheapest fattening food, should be used. Cattle with such a ration does not stand a long feeding period, but must be sold when finished, or, as reported, they take a set back, and cause a serious loss to the owner. Finally it may be said that variety which this ration lacks is very important, since it stimulates appetite, which a steer must have to make good gains.

Farm No. 5—This farm, located in Carroll county, is managed by a man who is said to be one of the most successful feeders of beef in Maryland. He feeds cattle only in the winter season, and makes them big and heavy, and weigh 1,400 to 1,500 pounds by the time they are ready to go to market. From his barns cattle go out well ripened and covered with a deep covering of thick flesh. Here cattle received much attention, many little kindnesses and a variety of appetizing foodstuffs. The ration consisted of good sweet clover hay, mixed with timothy, alfalfa, corn silage which would make fifteen barrels of corn to the acre, ground corn and some cottonseed meal. The alfalfa was never fed but once per day.

The ration which was finishing a bunch of cattle, which had made about 400 pounds gain at the rate of about two pounds per day, consisted of 20 pounds of silage, 5 pounds of alfalfa, approximately 9 pounds of mixed hay, and about 6 pounds of grain, which was 4 pounds of corn and 2 pounds of cottonseed meal.

KIND AND AMOUNT OF FOOD.	Dry Matter.	DIGESTIBLE NUTRIENTS.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total.	
	lbs.	lbs.	lbs.	lbs.	lbs.	
Silage 20 lbs	4.20	.18	2.18	.14	2.58	
Alfalfa 5 lbs	4.58	.55	1.98	.06	2.59	
Mixed Hay 9 lbs	7.707	.452	3.526	.141	4.119	
Corn 4 lbs	3.56	.316	2.668	.112	3.156	
Cottonseed Meal 2 lbs	1.836	.744	.338	.244	1.326	
Total	21.883	2.242	10.592	.757	12.781	1:6
Standard Ration	26.	2.7	15.	.7	18.4	1:6.14

This is an excellent ration, properly balanced, and furnishing a variety which keeps up the appetite of the steer for heavy feeding. All the feed except the cottonseed meal is raised on the place. Straw was used for bedding, but a large share of the bedding was made by shredding the coarse corn stover.

A rotation of crops, a liberal application of barnyard manure, and the plowing under of green crops have made the farm highly productive.

Farm No. 6—Now, going west to Garrett county, the feeding practiced there will be fairly well represented by a farm near Grantsville. The roughage consists of mixed hay, timothy and clover and corn stover. The grain consisted of eight pounds crushed corn and two pounds of oats.

Kind and Amount of Food.	Dry Matter.	Digestible Nutrients.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total.	
	lbs.	lbs.	lbs.	lbs.	lbs.	
Corn Stover 15 lbs..	9.00	.255	4.86	.105	5.07	
Mixed Hay 6 lbs....	5.138	.301	2.35	.094	2.746	
Corn & Cob meal 8 lbs	6.792	.352	4.80	.232	5.384	
Oats 2 lbs...........	1.78	1.84	.946	.084	1.214	
Total................	22.710	1.092	13.056	.515	14.404	1:12
Standard Ration....	26.	2.7	15.	.7	18.4	1:6.14

This ration is faulty, because it is too wide, and does not contain enough grain. The animal has to make too much of his gains from rough feed, which he will not do. As would be expected, the cattle in this instance were not making rapid gains. True, all the feed was raised on the farm, but nevertheless some bran, cottonseed meal or gluten meal could probably have been used with advantage. Some silage would have made it more palatable, and stimulated the animal's appetite.

Farm No. 7—In Dorchester county, on a farm near the Atlantic Coast, cattle were getting as a finishing ration 15 pounds of silage, corn and cob-meal mixed with brewer's grains half and half, about eight pounds, corn stover ten pounds, mixed hay four pounds, and cottonseed meal three pounds.

Kind and Amount of Food.	Dry Matter.	Digestible Nutrients.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total.	
	lbs.	lbs.	lbs.	lbs.	lbs.	
Corn Silage 15 lbs...	4.20	.180	2.18	.14	2.58	
Corn Stover 10 lbs...	6.00	.17	3.24	.07	3.38	
Mixed Hay 4 lbs.....	3.424	.20	1.564	.062	1.83	
Corn &Cob Meal 4 lbs.	6.00	.17	3.24	.07	3.38	
Brewers DryGr.4 lbs.	5.138	.301	2.35	.094	2.746	
CottonseedMeal 2 lbs.	1.836	.744	3.38	.244	1.326	
Total................	26.598	1.765	12.912	.680	15.242	1:8.2
Standard Ration.....	26.	2.7	15.	0.7	18.4	1:6.14

This ration has the required amount of dry matter, but a little too wide in nutritive ratio. The amount of fats and carbohydrates will do fairly well, but the protein is too low. A little more cottonseed meal could replace the cob in the cob-meal probably to good advantage.

The amount of grain going into the rations on the several farms above mentioned was very easily obtained, but the roughage was not weighed, and could only be estimated or approximated from the total fed out for a number of days.

Farm No. 8—On this farm, located in Talbot county, cattle had been fed for a great many years. In fact, a fully-detailed account of the work had been kept recorded very systematically in a note-book. From the book I quote the following data:

After getting the 20 head of cattle started, they were from December 12 given a ration consisting of twenty pounds of silage, three pounds of fodder, three pounds of oats, ten pounds of corn-meal, two pounds of middlings and one pound of cottonseed meal. Nothing was noted about what tables were used to derive the following figures:

FEED.	Dry Matter.	Protein.	Carbohydrates.	Fat.
Corn Silage 20 lbs.	3.90	0.24	2.36	.12
Corn Fodder 3 lbs.	1.65	.08	.88	.03
Crushed Oats 3 lbs.	2.27	.04	1.25	.02
Corn Meal 10 lbs.	8.73	.71	6.30	.39
Middlings 2 lbs.	1.69	.24	.94	.05
Cottonseed Meal 2 lbs.	.85	.36	.18	.12
Total	19.09	1.67	12.01	.73
Standard Ration	25.	2.07	14.8	.6

On December 19 the cattle were weighed, and the following table was made out, which gives results in good tabular form for reference:

CATTLE.	Dec. 19, weight	Dec. 12, weight.	Av. wt. of Steer.	Gain per head.	Av. rate per day.
	lbs.	lbs.	lbs.	lbs.	lbs.
5 Steers	6270	6150	1254	x24	3.42
5 "	6770	6670	1354	x20	2.85
5 "	5850	5730	1170	x24	3.42
5 "	6050	5900	1210	x30	4.28
Total Average	24940	24450	1247	x25	3.57

The cattle were weighed every week, and the above ration, although not up to the standard, was fed until the average gain per day showed a decline. On January 2 the cattle had been at feed for 42 days, and had gained 102 pounds, at the rate of 2.5 pounds per day. January 9 they had made a total gain per head of 132 pounds.

A change was made in the ration on January 30, and the following was given:

AMOUNT OF FEED GIVEN.	Dry Matter.	Protein.	Carbohydrates.	Fat.	Nutritive Ratio.
Corn Silage 20 lbs	4.18	.18	2.26	.14	
Corn Fodder 3 lbs	1.78	.51	.97	.02	
Oats Straw 2 lbs.	1.81	.02	.77	.01	
Oats in Straw lb	.89	.09	.47	.04	
Corn Meal 11.53 lbs	10.22	.92	7.63	.49	
Middlings 2.31 lbs	2.03	.29	1.22	.07	
Cottonseed Meal 1.16 lb	1.06	.43	.19	.14	
Total	21.97	2.44	13.51	.91	1:64
Standard Ration	25.	2.07	14.8	.6	1:6

On February 20 the cattle were weighed up, and it was found that the average gain was 255 pounds, at the rate of 2.8 pounds for the 91 days' feeding. But at the end of the next week the weighing showed a loss instead of a gain, because the cattle had suffered in a severe snow-storm.

The daily ration was again changed on March 21 to 10 pounds of silage, six pounds of hay, two pounds of oats hay, one pound of oats, 12.13 pounds corn-meal, 2.61 pounds middlings and 1.26 pounds of cottonseed meal. This ration furnished 24.23 pounds dry matter, 2.10 pounds protein, 14.74 pounds carbohydrates and 0.95 pounds fat.

The amount of silage was cut down because the manager sought to get the cattle in market condition for sale about April 10.

When data has been kept in so full a form, it makes the farm a veritable experiment station to the owner.

GROWING FEEDERS.

In no section is diversified farming followed so extensively as in the western counties of the State. In Garrett county beef production is carried on in connection with dairying. The kind of cattle which most of the farmers keep is grade Shorthorns. The cows are used in the farm dairy, while the steers are sold as stock cattle, or are fed out and sold to the butchers who supply the nearby coal-mining towns with meat. A few stock cattle are raised in the western part of Washington county. These are quickly gathered up by stockmen, and seldom do any of them get very far before they are put into feed lots and finished for the local, and sometimes Baltimore butcher trade. Why more cattle are not raised on these mountain pastures is not easily understood. The chief trouble seems to lie in the fact that sufficient forage is not raised to maintain the cattle and breeding stock during the winter season.

PURE BRED HERDS OF BEEF CATTLE.

The number of pure bred herds of beef cattle in Maryland, though small, yet is sufficient to supply the demand for breeding stock. They are distributed over the different parts of the State, and consist of Shorthorns, Herefords and Aberdeen Angus. Some of the stock have been to several of the leading fairs, and returned home with the first prizes. Although good bulls are produced, the dairy interests are holding their sale in check.

BEEF PRODUCTION AND DAIRYING.

When considering the price which some farmers are getting for their milk, and the extra labor which must be employed, the net returns would be greater and easier obtained, if stock feeding and the raising of feeders was given more attention. Some fine feeding cattle have been produced in the western part of Washington county by the use of a good beef sire on the semi-dairy cows. The grade Hereford herds in Talbot county have produced many fine animals, which have been finished at an early age, and made into toppers at the Philadelphia market. From these herds the surplus stock has been finished and sold pretty much as baby beef, and when marketed early the heifers sold as well as the steers. There was no distinction made because of sex.

Dairying is no easy task, and requires considerable labor at best, and a great many boys on the farm have no taste for the work. Such boys seldom prove to be good dairy farmers, and they would probably find beef-stock raising and fattening to be more congenial and, under present conditions, as profitable.

MARKETS FOR BEEF.

Maryland has four large markets to which fattened cattle are taken for sale, namely, Pittsburg, Washington, Baltimore and Philadelphia. From sale reports Philadelphia has proven the most favorable. In addition to these markets very many animals are in active demand by local butchers. In Garrett and Allegheny counties, especially about the mining towns, there is a strong demand for all of the beef produced in the nearby districts.

Many ways of marketing cattle are available. Some are consigned to commission merchants; some sold directly to local and distant butchers, who visit herds and buy their own cattle, and some are sold to buyers and shippers. Some men of Cecil county sell their cattle to a butcher, who comes out to the farm and takes the animals, one or more, as soon as they are ready for the block. At one place the bullocks were slaughtered on the farm, and the owner paid from the dressed weight.

When consigning to commission merchants at a distant market the cattle have been sent by rail, or by water. Transportation from the farm to market has more or less unavoidable loss through driftage; but these losses have to be met by an increased price. Driftage can be reduced to a minimum by not feeding the animals too heavy on grain just previous to starting for market, and also by not permitting them to drink too much.

Cattle will go to market best on dry feed and little water. This is especially true when driven to market. Men driving in from Montgomery county to Washington have had light driftage until the cattle received water en route. Then, if watered before the cattle arrived at the yards, the loss was estimated to be two or three times greater.

PROFITS.

The amount of profit which a man is able to make is dependent upon the man and his ability to master the forces about him. In the cattle business one man does well by handling registered animals; another does better with grades, and still another will do best by feeding and fattening what his neighbor raises. When feeding cattle some men have made as much on stock at a six months' feed as others have made in a year's feeding. Such a result is not because of a reserve of capital, but because there had been more business sagacity and more skilful management of the stock and the food given. Profits on finished bullocks have been ranging from 20 to 36 dollars per head. But some men, given away either to the fever of speculation, or to the fear of losing, have sold for far less profit.

The margin of profit on which cattle are to be fed is getting quite small. The possibility of having an advance of $2.00 per hundred on the cost price is usually out of the question. The cost of producing the animal for the feed lot has increased, and many other things, acting on the markets for beef, have had an influence on the chance for large profits, so that now the smaller margin of $1.00 to $1.50 does not allow much more than selling prices for feed. At a few farms, cattle were being fed under contract with the commission men for only $1.00 advance on the hundred (under this contract the cattle were to be delivered at a certain date). But experience has shown men that a margin less than $1.00 on the hundred is very doubtful business, and seldom attended with success.

One dollar per hundred advance usually just about pays for the feed, and leaves the manure for the labor and profit.

To illustrate the point of margin in cattle feeding, the following example will be given:

A stockman buys a 900-pound steer at $3.85 per hundred, paying $34.65 for him; he sells him at $5.00 per hundred, after he has made 300 pounds gain, and at the sale receives $60. Now the margin or advance in this instance is the difference between $3.85 and $5.00, or $1.15.

Here a question naturally arises: How much profit can be figured from the above transaction? Not less than $8.00 per hundred should be allowed to cover the cost of feed, and of the labor to care for the cattle.

The first cost of animal is 900 pound at $3.85 (100)	$34.65
Cost of gains, 300 pound at $8.00 (100)	24.00
Total cost	$58.65
Selling price and total return, 1200 pounds at $5 per 100	$60.00

Net profit, $60.00 minus $58.65....$1.35.

The gross returns are $60.00 minus $34.65 equals $25.35.

Then, again, the interest on $60 at six per cent. is $3.60 per year, and for four months, the length of the feeding period, $1.20; therefore $1.35 profit allows more than six per cent. on the investment.

The above figures are taken from average weights, prices paid out and received for stock, and will represent average conditions fairly well.

FEED REQUIRED TO GROW STEERS.

By H. J. Patterson.

Information is frequently requested as to the amount of food required to grow a steer. In order to make this information more generally available, the records in Tables 1 to 6 are appended to this bulletin.

TABLE I.

Record of Feea Consumed and Gains made by Steers Nos. 73 and 74. Aberdeen Angus Calves entitled to Registry.
(Weaned at 5 days old.)

Mo.	Date 1905	Steer † 73 (Dropped Feb. 23)					Steer 74 † (Dropped Feb. 28)				
		Milk	Grain	Hay	Wt.	Gain	Milk	Grain	Hay	Wt.	Gain
1	March	224	10	......	105	......	184	6	......	97	......
2	April	240	50	......	144	39	240	50	......	140	43
3	May	366	69	18	194	50	366	69	18	185	45
4	June	538	71	50	225	31	540	67	50	226	41
5	July	558	74	90	273	48	558	74	90	277	51
6	Aug.	Pasture.	48	......	299	26	Pasture.	50	......	315	38
7	Sept.	"	31	......	327	28	"	31	......	363	48
8	Oct.	"	74	......	332	5	"	77	......	381	18
9	Nov.	"	174	140	369	37	"	174	140	409	28
10	Dec.	"	225	180	420	33	"	225	181	468	59
	1906										
11	Jan.	"	244	186	475	55	"	214	186	490	22
12	Feb.	"	224	215	552	77	"	202	215	552	62
13	Mar.	"	240	275	615	63	"	236	275	617	65
14	April	"	300	240	653	38	"	295	239	680	68
15	May	"	324	200	693	40	"	310	215	731	51
16	June	"	324	230x	735	42	"	308	230	791	60
17	July	"	335	230	781	46	"	335	230	827	36
18	Aug.	"	253	334	772	9	"	246	276	830	3
19	Sept.	"	330	300	815	43	"	330	300	913	83
20	Oct.	"	341	310	858	43	"	341	310	953	40
21	Dec.	"	300	250	852	6	"	300	250	967	14
22	Dec.	"	324	228*	862	10	"	314	257	994	27
	1907										
23	Jan.	"	310	225*	917	55	"	310	255	1053	59
24	Feb.	"	280	340x	963	46	"	280	345	1087	34
	Mar.	"	150	168	986	23	"	150	194	1111	24
	Total	1926	5135	4209		881	1888	4994	4255		1014

Steer † 73
Gained 1.18 lbs. per day for 745 days.
Required for each pound of gain.
5.83 lbs. of grain.
4.78 " " hay.
2.18 " " milk.

Steer † 74
Gained 1.36 lbs. per day.
Required for each pound of gain.
4.92 " " grain.
4.19 " " hay.
1.08 lbs. of milk.

x Crimson clover hay. * Corn fodder.

TABLE II.

Record of Feed Consumed and Gains made by Steer 76.
(Sire Aberdeen Angus. Dam Shorthorn.)
Weaned March 1, 1906. 4½ months old, Weighed 330 lbs.

1906.	Steer 76 (dropped October 12, 1905).			
	Grain.	Hay.	Weight.	Gain.
March 15	....	....	330	....
March 30	70	30	343	13
1 April	177	120	391	48
2 May	225	110	451	60
3 June	236	160x	507	56
4 July	244	120	558	51
5 August	184	285	574	16
6 September	270	300	655	81
7 October	279	310	712	57
8 November	300	250	740	28
9 December	314	225	757	17
10 January	310	202	820	63
11 February	280	285	868	48
12 March	150	133	890	22
Total	3039	2530	....	560

Average gain per day 1.53 lbs. Food consumed for each pound of gain.
5.43 lbs. of grain.
x—Crimson clover hay. 4.52 " of hay.

TABLE III.

Record of Feed Consumed and Gains made by Steer No. 77.
(Sire Aberdeen Angus, Dame Shorthorn).
Weaned at 6 days old.

Mo.	Date.	Steer No. 77, Dropped August 25, 1905.				
		Milk.	Grain.	Hay.	Weight.	Gain.
	September 1	....	....	....	79	....
1	September 30	230	4	....	82	3
2	October	60	25	20	94	12
3	November	120	60	60	123	29
4	December	186	58	45	164	41
5	January	....	62	65	204	60
6	February	....	112	84	255	51
7	March	....	125	125	328	73
8	April	....	210	150	384	56
9	May	....	259	115	420	36
10	June	....	240	160	492	72
	Total	596	1155	824		413

July 5th Killed. Dressed 259 lbs. or 52.6%. Average gain per day 1.33 lbs.
Food consumed for each pound of gain.
Milk 1.44 lbs. Grain 2.8 lbs. Hay 2.0 lbs.

TABLE IV.

Food Consumed by Steers During their First Year.

STEER.	TOTAL FOR 12 MONTHS.			FOR EACH POUND OF GAIN.			Gain.
	Milk.	Grain.	Hay.	Milk.	Grain.	Hay.	
73	1926	1294	879	4.3	2.9	2.0	447
74	1888	1239	879	4.1	2.7	1.9	455
76	....	1685	1335	....	4.1	3.5	382
77	596	1155	824	1.4	2.8	2.0	413
Average.				3.3	3.1	2.3	424

TABLE V.

Food Consumed by Steers During their Second Year.

STEER.	TOTAL FOR 12 MONTHS.		FOR EACH POUND OF GAIN.		Gain.
	Grain.	Hay.	Grain.	Hay.	
73	3841	3330	8.8	7.6	434
74	3755	3376	6.7	6.0	559

The tables in the main explain themselves, but it is worthy of special note that it requires from two to three times as much feed to produce a pound of gain during the steers' second as their first year. These figures also show quite conclusively that steers to be profitably grown must be made to gather their own food as much as possible, and thus reduce labor expense to a minimum, and that at best they must be used as a means for converting unmarketable products into a marketable form. All of these records were for calves from the same Aberdeen Angus bull.

RATIONS FED.

The steers received, except for one or two months, when noted in Tables 1 and 2, a good quality of mixed timothy and clover hay as roughage. They were fed all of the hay they could eat at all times.

The grain rations were varied from time to time, according to what was available, and also in order to give a variety. They were made up as follows:

For Steers Nos. 73-74.

First and Second Months—Wheat bran and malt sprouts in equal parts, and Blachford's Calf Meal in the milk.

Third Month—Wheat bran, wheat middlings and malt sprouts mixed in equal parts.

Fourth Month—Malt sprouts and Blachford's Calf Meal mixed in equal parts.

Fifth and Sixth Months—Wheat bran, malt sprouts and Blachford's Calf Meal mixed in equal parts.

Seventh and Ninth Months—Wheat bran and gluten feed mixed in equal parts. This, with the hay, gave a nutritive ratio of 1:4.7.

Tenth and Eleventh Months—Wheat bran, hominy chop and gluten feed, mixed in equal parts. This, with the hay, gave a nutritive ratio of 1:5.5.

Twelfth to Eighteenth Month—Hominy chop, six parts; cottonseed meal, three parts; gluten feed, one part. This, with the hay, gave a nutritive ratio of 1:5.

Nineteenth Month—Hominy chop, six parts; cottonseed meal, three parts; wheat bran, one part.

Twentieth Month—Corn meal, two parts; cottonseed meal, two parts; wheat bran, one part; sucrene, two parts.

Twenty-first to Twenty-fifth Month—Sucrene alone (for description and analysis of same, see Bulletin 117). This, with the hay, gave a nutritive ratio of 1:5.0.

For Steer No. 76.

First to Sixth Month—Hominy chop, six parts; cottonseed meal, three parts, and gluten feed, one part. This, with the hay, gave a nutritive ratio of about 1:5.

Seventh Month—Corn meal, two parts; cottonseed meal, two parts; wheat bran, one part, and sucrene, two parts.

Eighth to Twelfth Months—Sucrene.

For Steer No. 77.

First Month—Wheat bran and Blachford's Calf Meal, mixed in equal parts.

Second to Fourth Month—Wheat bran and gluten feed in equal parts.

Fifth Month—Wheat bran, hominy chop, and gluten feed mixed in equal parts.

Sixth to Tenth Month—Hominy chop, six parts; cottonseed meal, three parts; gluten feed, one part.

	STEER No. 1.				
	Milk	Grain	Hay	Weight	Gain
1901					
October	237	22	....	120	......
November	233	43	....	149	......
December	333	95	....	194	......
1902					
January	351	13	17	227	.....
February	306	138	23	282	......
March	332	191	24	317	......
April	384	203	40	408	288
Total	2187	705	104	....	......
May 1st to November 1st	......	462	Pasture.	528	120
to November 1st, 1903	Grain	Silage	and Hay	1001	473

	HEIFER No. 2.				
	Milk	Grain	Hay	Weight	Gain
1901					
October	237	22	....	126	......
November	233	43	....	142	......
December	338	75	....	208	......
1902					
January	357	55	17	278	......
February	314	126	21	345	......
March	334	177	31	304	......
Total	338	210	66	484	358
April	2201	708	135	....	......
May 1st to November 1st	......	462	Pasture	471	13
to November 1st, 1903	......	....	....	785	314

	STEER No. 3.				
	Milk.	Grain.	Hay.	Weight.	Gain.
1901					
October	237	22	....	122	......
November	233	43	....	146	......
December	334	95	....	185	......
1902.			....		......
January	351	13	17	226	......
February	306	138	23	260	......
March	332	191	24	292	......
April	384	203	40	359	237
Total	2177	710	104	....	......
May 1st to November 1st	......	462	Pasture.	597	238
to November 1st, 1903	......	....	....	1005	480

DATE	HEIFER NO. 4.				
	Milk	Grain	Hay	Weight	Gain
1901					
October	152	15		94	
November	233	43		119	
December	338	75		168	
1902					
January	357	55	17	217	
February	307	126	21	277	
March	334	177	31	337	
April	388	210	66	408	314
Total	2109	701	135		
May to November	Fed	Grain	Hay	633	225
to November 1st, 1903					
Grain, Silage and Hay				453	320

Date	STEER NO.8				
	Milk	Grain	Hay	Weight	Gain
1901					
October					
November					
December				93	
1902					
January	357	55	17	130	
February	313	126	21	183	
March	334	177	31	230	
April	388	210	66	307	214
Total	1392	568	135		
May to November	Fed	Grain	and Hay		
to November 1st, 1903				522	215
Grain, Silage and Hay				862	340

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STABLE MANURES.

By W. T. L. Taliaferro* and H. J. Patterson.

PREFACE.

The experiments reported upon in this bulletin were planned by and conducted under the general supervision of W. T. L. Taliaferro, who was Agronomist of the Experiment Station from 1900 to 1906. The preparation of the matter for publication, and the discussion of the results, has been done by H. J. Patterson, with the assistance of Prof. Taliaferro, who has reviewed and revised the same.

EXPERIMENTS CONDUCTED.

The experiments were conducted on two series of plots. One covered a period of three years, and was located in Field No. 13, on the north side of the farm, just west of and adjoining the B. & W. pike. The other covered a period of seven years, and was in Field No. 38, located south of the Experiment Station buildings, and east of and adjoining the pike.

The manure was applied to the first corn crop, and only once during each four-year rotation, at the rate of ten tons per acre, and was as nearly uniform as it was possible to have it. The manure was mixed horse and cow manure, and represented fairly well the grade available on many Maryland farms.

The following is a list of the experiments conducted and the questions which it was aimed to get some definite information concerning:

1. Comparison of applications of fresh and rotted manure.
2. Time of application of manure—
    (a) Fresh vs. Rotted.
3. Plowing under vs. top dressing of manure.
4. Plowing manure under in the fall vs. spring.
5. Plowing manure under different depths.

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*Resigned the position of Agronomist of the Experiment Station in order to devote all his time to College work.

6. Subsoil plowing in conjunction with the use of manure.
7. Manure alone vs. manure and commercial fertilizer.
8. Comparison of manure and straw.
9. Effect of fresh vs. rotted manure on crimson clover.
10. Effects of manure on the stand of corn.

The general treatment of the plots was uniform. The crop rotation was as follows:

First Year—Corn (planted on sod land); Crimson clover seeded at last working of corn.

Second Year—Crimson clover turned under for corn (wheat seeded in corn stubble).

Third Year—Wheat (timothy and clover seeded in wheat).

Fourth Year—Timothy and clover hay.

The results given in the tables in the following pages represent the average yields obtained from four crops of corn and two crops of wheat, thus passing through the rotation twice. The yields of hay were lost so cannot be given in the tables.

(1) COMPARISON OF FRESH AND ROTTED MANURE.

The applications of fresh manure were made by taking it directly from the stable, and spreading it on the land, at the rate of ten tons per acre, applied with a manure spreader.

In the rotted manure series, plots 2 and 4, of Field 38, received well-rotted manure at the rate of 10 tons per acre, taken at each application from a large heap of that material.

For each of the other rotted manure plots a ton of fresh manure was hauled out and heaped near the plot in sufficient time before spreading to allow it to decompose into a condition which would be generally recognized as well-rotted manure.

The results given in the following table are the average of twelve one-tenth acre plots. Fresh manure was applied to six plots, and rotten manure to six plots, the plots alternated.

TABLE I.

Comparison of Yields from applications of Fresh and Rotted Manure on Field No. 38.

(yields per acre in bushels)

	* Corn Bushels.	† Wheat Bushels.
Unmanured (average of plots 5, 10, 15, 20,)	38.1	16.1
Fresh Manure (average of plots 1, 3, 7, 9, 13, 16,)	70.7	19.7
Rotted Manure (average of plots 2, 4, 8, 11, 14, 17,)	65.1	19.1
Gain from fresh manure	32.6	3.6
Gain from rotted manure	27.6	3.0
Gain of fresh over rotted manure	5.0	0.6

* Average of 4 crops. † Average of 2 crops

The yields of fodder and straw were in favor of the fresh manure, and were in about the same proportions as given for the grains. The observations on the growth of grass showed decidedly in favor of the fresh manure, and were even more marked than with the other crops.

Since well-handled manure in decomposition loses a portion of all its constituents, but relatively more of woody matter than of nitrogen and mineral elements, rotted manure is relatively richer than fresh manure. Plots 2 and 4, of Field 38, therefore received rather more actual plant foods than any of the other plots. They received practically the same amount of humus-making material as the fresh manure plots, and rather more than the other rotted manure plots, whose quotas of manure had lost something during decomposition beyond the limits of the respective plots.

Table 3 shows the yields of plots 2 and 4, compared with the yields of the adjacent plots of 1 and 2, which received the same treatment otherwise than the kind of manure.

Table 4 shows the yields of the other rotted and fresh manure plots in Field 38.

TABLE II.

Comparison of Yields from Application of Equal Quantities of Fresh and Rotted Manure.

	Corn* Bushels.	Wheat† Bushels.
Fresh Manure (average of plots 1 and 3)...........	82.8	19.9
Rotted Manure (average of plots 2 and 4).........	71.6	22.9
Gain from Fresh Manure over Rotted.............	11.2	—3.0

* Average of 4 crops. † Average of 2 crops.

TABLE III.

Comparison of Yields from Application of Equal Quantities of Manure Applied.

Fresh from the Stable. Rotted in a heap before application.

	Corn* Bushels.	Wheat† Bushels.
Fresh Manure (average of plots 7, 9, 13, 16,.......	64.9	18.5
Rotted Manure (average of plots 8, 11, 14, 17,.....	61.8	17.2
Gain from Fresh Manure over Rotted............	3.1	1.3

* Average of 4 crops. † Average of 2 crops.

Before discussing Tables 3 and 4, it may be stated that Field 38 was selected for this experiment because of its apparent uniformity, but it soon became evident that it decreased in fertility quite regularly from north to south, the direction in which the plots were numbered. As the fresh and rotted manure plots were alternated, and every fifth plot was left unmanured as a check plot, this difference in fertility did not interfere with the general result of the experiment, but gave additional interest in the comparison of the use of manure on soils of different degrees of fertility.

In general texture, as determined by borings, the soil throughout was quite homogeneous.

The results shown in Table 4 do not differ materially from those shown in Table 1, the fresh manure showing a slight gain over the rotted in both wheat and corn. From Table 3, however, it appears that the fresh manure gave the better yields with corn, and the rotted manure with wheat. This may be to some extent accounted for in the grosser feeding habit of corn, which enabled it to utilize the fresh manure to better advantage than the wheat, and in the fact that plots 2 and 4 received a slightly greater amount of actual plant food.

TABLE IV.

Comparison of Yields from application of Fresh and Rotted Manure on Field No. 13.

(yields per acre)

	CORN *		Wheat †	
	Grain.	Fodder.	Grain.	Straw.
Unmanured (plot 18)	75.1	6150	19.3	890
Fresh Manure (average of plots 19, 21)	92.6	7225	21.3	1120
Rotted Manure (average of plots 17, 20)	82.4	6500	20.3	860
Gain from fresh manure	17.5	1075	2.0	230
Gain from rotted manure	7.3	350	1.0	—30
Gain of fresh over rotted manure	10.2	725	1.0	260

* Average of two crops. † One crop.

The results obtained in both of these tests show clearly in favor of the use of fresh manure applied directly from the stable. When it is remembered that the use of the manure in this way would do away with at least one handling of it, the relative profits are greater than are represented by the increased yields.

The effects of the manures on the wheat crops are not so marked as with the corn, but this would naturally be expected, as two crops of corn had access to the manure before the wheat, and the remaining manure was thoroughly decomposed.

(2) WHEN SHALL MANURE BE APPLIED?

In connection with the use of manure, the question is frequently raised as to the best time of the year to apply it. This is particularly the case when discussing the question of applying the manure directly from the stables. With an idea of getting some data on this point, applications were made at four different periods. The applications were made on sod land before plowing, and previous to planting the land to corn.

The results are given in the following table:

TABLE V.

Results of applying Manure at different Seasons.

(Experiments conducted in Field 38. Yields per Acre.)

	Fresh Manure.		Rotten Manure.	
	Corn* Bushels.	Wheat† Bushels.	Corn* Bushels.	Wheat† Bushels.
Summer (July 26)	82.8	20.0	71.6	22.0
Fall (November 27)	69.1	18.4	68.0	17.3
Winter (January 12)	58.2	17.9	....	....
Spring (March 15)	57.5	17.8	61.4	18.0

* Average of 4 crops. † Average of 2 crops.

The results as given in the above table show clearly in favor of getting the manure on the land as long in advance of the time the crop is to use it as possible. The results as a whole are in favor of the use of fresh manure, but when the applications were made in the spring the rotted manure gave slightly better yields.

(3) COMPARISON OF APPLYING MANURE BEFORE AND AFTER PLOWING.

Plowing Under vs. Top Dressing.

The manner of applying manure should probably be varied with the character of the soil and the crop; yet usually the same results would be expected, on the average corn, wheat and grass soil, from a given practice.

TABLE VI.

Showing results of applying Fresh and Rotted Manure before and after Plowing.

(Experiments conducted in field 13. Yields per Acre.)

	Fresh Manure.				Rotted Manure.			
	Corn*		Wheat†		Corn*		Wheat†	
	Grain	Fodder.	Grain	Straw	Grain	Fodder.	Grain	Straw
	Bu.	Lbs.	Bu.	Lbs.	Bu.	Lbs.	Bu.	Lbs.
Before Plowing.........	87.2	6950	20.3	1080	82.3	6550	19.8	760
After Plowing..........	98.1	7500	22.3	1160	82.6	6450	20.7	960
Gain from using Manure as a Top-Dressing....	10.9	550	2.0	80	0.3	—100	0.9	200

* Average of 2 crops. † Average of 1 crop.

The above results are clearly in favor of applying the manure after plowing as a top dressing. They also show decidedly in favor of the use of fresh manure.

(4) COMPARISON OF PLOWING MANURE UNDER IN THE FALL AND SPRING.

The question arises in the minds of the farmer as to whether the loss in manure would not be prevented by plowing it down in the fall, instead of leaving it exposed on the surface all winter. In order to get some definite data on this point, the tests reported on in Table 5 were conducted. It must be remembered that the manure was applied but once in the rotation, and that to the first crop of corn, and that the effects on the wheat was only what remained after two crops of corn had already had access to the manure.

TABLE VII.

Showing yields of Corn and Wheat from Plowing Manure under in Fall and Spring.

(Tests conducted in field 38. Yields per acre.)

	Fall Plowing.		Spring Plowing.	
	Corn Bushels.	Wheat Bushels.	Corn Bushels.	Wheat Bushels.
Manure applied in the Summer........	75.9	20.9	78.4	21.1
Manure applied in the Fall............	62.2	17.4	69.9	18.3
Manure applied in the Spring..........	....	....	57.5	17.8

The results given in the above table are slightly, but uniformly, in favor of allowing the manure to remain on top of the land during the winter, and plowing it down in the spring, rather than plowing it down in the fall. This is probably due to the conditions near the surface being more favorable to nitrification, and consequently more of the manure has become available for crops.

Farmers sometimes object to the spreading of manure in summer, in the belief that when manure is so spread the hot summer suns burn out its substance, as they express it, and make it comparatively valueless. An inspection of Table 5 shows this belief to be unfounded. The manure spread in July gave better results than that spread in either Fall or Spring.

(5) COMPARISON OF PLOWING MANURE UNDER TO DIFFERENT DEPTHS.

In this experiment the manure was applied in the winter on sod land, and was plowed under at once. On one plot the land was plowed to the usual depth prevailing in that field, or seven inches deep, and the other plot was plowed but five inches deep. The effects of this treatment on the yields of corn and wheat are given in the following table:

TABLE VIII.

Showing the results of Plowing Manure under different depths upon yields of Corn and Wheat.

(Conducted on field 38. Yields per acre.)

	Corn* Bushels.	Wheat† Bushels.
Manure plowed under 7 inches	57.9	18.1
Manure plowed under 5 inches	56.5	14.7
Gain from deep plowing	1.4	3.4

*** Average of 4 crops. † Average of 2 crops.**

While these results do not show a very great difference, yet they are in favor of the deeper plowing, and as they were uniformly so from year to year with every crop, it may be safely concluded that it is usually best to plow deep, and that it is not harmful to plow the manure under deep. These results would seem to indicate that the contention of some farmers that manure should not be put in very deep is unwaranted, and that putting it in deep would probably stimulate the development of roots, and get additional advantages therefrom.

(6) SUB-SOIL PLOWING IN CONJUNCTION WITH MANURING.

The question as to the value of sub-soiling on stiff land is frequently asked, and this test was conducted in order to get some data on the subject.

The land was manured in the winter with fresh manure, and plowed in the spring. The ordinary plow turned the furrow to the depth of five inches, and the sub-soil plow followed in the same furrow, loosening the soil to the depth of five inches, but none of the sub-soil was brought to the surface.

The effects of this treatment on the yields of Corn and Wheat are given in the following table:

TABLE IX.

Showing results of Sub-Soil Plowing in connection with Manure.

(Conducted in field 38. Yields per acre.)

	Corn Bushels.	Wheat Bushels.
Fresh Manure and Sub-Soil Plowing................	50.9	12.5
Fresh Manure and Plowed under 7 inches..........	46.2	13.3
Gain from Sub-Soil Plowing.......................	4.7	....
Loss from Sub-Soil Plowing.......................	....	0.8

These results are not very decisive, as the corn crop shows slightly in favor of the use of the sub-soil plow, while the yield of wheat is slightly against it. At best it would appear that there was not sufficient advantage to warrant the extra expense involved.

(7) COMPARING THE USE OF MANURE ALONE WITH MANURE SUPPLEMENTED WITH COMMERCIAL FERTILIZERS.

It is commonly recognized that manure is relatively rich in nitrogenous plant food and deficient in potash and phosphoric acid. It is also frequently claimed that fresh manure is not quick enough in its action, and that it should be supplemented with some readily available plant food, such as is furnished by commercial fertilizers.

With the idea of testing some of these points in part, the tests reported upon in the following table were made:

TABLE X.

Showing the results of the use of Manure and Fertilizer in Combination.

	FIELD 38.		FIELD 13.	
	Corn Bushels.	Wheat Bushels.	Corn Bushels.	Wheat Bushels.
26. Unmanured	33.3	13.6	75.1	19.3
27. Manure alone	46.2	13.3	....	....
28. Manure and 300 pounds complete Fertilizer, broadcast	53.3	14.3	75.0	19.3
29. Manure and 50 pounds complete Fertilizer in row	53.3	14.6	89.0	20.3
30. Manure and 300 pounds Kainit broadcast	69.5	15.1	....	....

A study of these results show that the different treatments did not have much effect on the wheat crops. The results obtained with the use of a small quantity of fertilizer in the row at the time of seeding, and a larger quantity broadcast, gave practically the same result in Field 38, but showed decidedly in favor of the small quantity on Field No. 13. This can probably be explained by the fact that the seasons when the tests were made on Field No. 13 were much dryer than those with Field No. 38. This would substantiate the claim of many farmers that in dry seasons the use of more fertilizer than just enough to start the corn well is a disadvantage, as the larger quantities have a tendency to make a growth of fodder at the expense of grain.

The use of Kainit with the manure seemed to exert a beneficial influence every year, and it was more marked in dry than wet seasons. From the results here its use in conjunction with manure on corn can certainly be recommended.

(8) COMPARISON OF APPLICATIONS OF MANURE WITH APPLICATIONS OF WHEAT STRAW.

In order to determine the value of applications of straw to the land, tests were made of its use in comparison to manure. In some sections of the State many farmers make a practice of spreading surplus straw over the land. In other sections, where there are considerable amounts of straw almost going to waste, and relatively little manure made, it is very seldom that any of it is spread over the land in a fresh state.

The straw was applied at the rate of two tons per acre in the Summer or early Fall, and plowed down the following Spring. The following table gives the effects on the yields of corn and wheat:

TABLE XI.

	Corn Bushels.	Wheat Bushels.
Unmanured	34.0	16.3
Straw	58.3	19.0
Fresh Manure	86.1	22.1

These results show that the straw is not as valuable to apply as the manure, though it will produce a considerable increase in yield, and should be used fresh wherever available, rather than allow it to go to waste.

(9) EFFECT OF FRESH VS. ROTTED MANURE ON CRIMSON CLOVER.

It has been mentioned that in each rotation the first crop of corn was followed by Crimson clover, which was plowed under in preparation for the second corn crop. Since the clover was turned under it was not possible to accurately compare yields on the respective plots, but careful observations were made just before plowing. Though the clover was not particularly good in any case, it was noticeably thicker and taller on the fresh manure than on the rotted manure plots, and better on both series of manured plots than on the unmanured.

TABLE XII.

Average Yields of Corn in Field 38 in the First and Second Years of each Rotation.

	CORN BUSHELS.		
	Average of '01 and '05.	Average of '02 and '06.	Loss in Second Year
Unmanured (Ave. of plots 5, 10, 15, 20)	44.2	31.9	12.3
Fresh Manure (Ave. of plots 1, 3, 7, 9, 13, 16	79.9	61.9	18.0
Rotted Manure (Ave. of plots 2, 4, 8, 11, 14, 17)	74.8	55.4	19.4

This indirect effect of the fresh manure in contributing more humus and nitrogen through the medium of the Crimson clover may account to some extent for the slightly less falling off in the yields of the fresh manure plots as compared with the rotted manure plots in the second year of each rotation, as seen in the above table.

STAND OF CORN ON MANURED AND UNMANURED PLOTS.

During the progress of these manure experiments in Field 38, it was evident that the soil of all the plots was falling off in productiveness, the manure applied being insufficient to supply the drain involved in the removal of crops. In the manured crop the effect of this draft could be distinctly seen in the difference in the mechanical condition of the soil. It became lighter in color, lost much of its friability and porosity, became more sticky and dense, with a tendency to break into a hard surface crust, conditions which were aggravated by the unusually wet seasons, which interfered with the regular cultivation of the corn crops. As early as 1905 the changing conditions became evident on the unmanured plots, and showed their effect primarily in the poor stand of corn on these plots, as compared with those which had received manure. All of the plots were planted with seed as nearly equal in vitality as could be had, from tested ears, and well mixed after shelling.

On the manured plots the young plants came up promptly and regularly, and grew rapidly. On the unmanured plots they came up slowly and irregularly, and grew slowly, affording ample opportunity for insect depredation, from which they suffered severely. As a result the stand of plants on these plots was very poor. On September 25, 1905, just before the crop was harvested, a count was made of the plants on each plot, the results of which are given in Table 13. While no count of stalks was made in 1906, the relatively poor stand on the unmanured plots was apparent to the most casual observer.

TABLE XIII.

Showing number of Corn Plants per acre on Manured and Unmanured Plots in Field 38, September 25, 1907.

	No. of Plants per Acre.
Fresh Manure (Ave. of plots 1, 3, 7, 9, 13, 16)	8220
Rotted Manure (Ave. of plots 2, 4, 8, 11, 14, 17)	8170
Ave. of all Manured plots	8195
Unmanured (Ave. of plots 5, 10, 15, 20)	5440
Difference between Manured and Unmanured	2755

To this difference in the stand must be attributed much of the difference in yields of the manured and unmanured plots. That the difference in stand was attributable to the poor mechanical condition of the latter plots, owing to their lack of humus, may be inferred from an inspection of Table I, where it appears that the unmanured plots approximated more closely to the manured in the yields of wheat than of corn, it being generally recognized that wheat is better adapted than corn to succeed in dense, compact soils.

APPENDIX.

The matter printed in the appendix is given in order to answer the many questions of a miscellaneous character on manure that are not covered in the experiments conducted.

FARM MANURES.

DESIGNATION AND KIND OF FARM MANURES.

The term farm manures in its broadest sense is used to designate all materials (not included under green manures and commercial fertilizers) that may be made or accumulated on a farm, and which can be used for improving the fertility of the land, but the term is most commonly used to designate the excrements of domestic animals.

The term stable manures is used to designate manure just as it comes from the stables, and which is used in the fresh state. Yard or barnyard manure is the term applied to manure which has accumulated, or been kept for some time in a pile in the barnyard. The name of fresh manures is applied to manure that is only a few hours old, and as it comes from the stable. Rotted manure is the name used to designate manure that has gone through considerable fermentation, and more or less disintegrated. Mixed manure is the excrements of different species of animals, with the bedding or other material thrown together. Manure from a single species of animal is designated by the kind of animal producing it.

THE VALUE OF FARM MANURES.

The domestic animals kept in the United States produce annually several billions of dollars worth of manure. The value of manures varies considerably, depending upon, first, the kind and age of the animals; second, the kind and amount of food consumed; third, the kind and amount of absorbents employed; fourth, the system followed in collecting, preserving and utilizing the manure.

Even though these factors may vary greatly, the value of manure, when applied to the land, comes through the following influences:

(a) By contributing to the supply of plant food.
(b) By improving the physical condition of the soil.
(c) By inducing chemical changes.
(d) By introducing beneficial bacteria and ferments.

FARM MANURES AS A SOURCE OF PLANT FOOD.

While the composition of farm manure varies with the conditions already enumerated, yet they all supply more or less of the essential plant foods—nitrogen, phosphoric acid (phosphorous) and potash. The average mixed farm manure contains these plant foods in the proportion of approximately ten parts of nitrogen to six parts of phosphoric acid and eight parts of potash. Mixed stable manure contains on the average about 0.50 per cent. nitrogen, 0.30 per cent. phosphoric acid, and 0.40 per cent. potash. All manures contain as a rule both the dung and urine of animals, mixed with some absorbents. The dung consists chiefly of the undigested portions of the food consumed, which was first ground fine by the teeth, and then saturated and softened with the water and digestive fluids of the alimentary canal. This dung, while composed largely of the woody tissues of the food eaten, yet, being very fine and soft, will decompose and give up its plant foods very readily. Dung contains approximately one-third of the total nitrogen, one-fifth of the total potash, and nearly all of the phosphoric acid voided by animals. The plant foods in dung are not soluble, and must be decomposed before they can be utilized by plants. The urine of domestic animals contains compounds which have been formed in the body. It usually contains about two-thirds of the total nitrogen, four-fifths of the total potash, and very little of the phosphoric acid voided by the animal. While the elements found in the urine are in solution, yet they are not immediately available as food for plants, but become so much more quickly than the constituents found in the dung.

In practice it has been found that while farm manures furnish some of all of the essential plant foods, yet it is considered unbalanced, as it does not supply them in the proportions found most satisfactory in practice. This is due to the fact that soils gain nitrogen through other sources, and that the potash in soils becomes available through various means more rapidly than the phosphoric acid.

PHYSICAL EFFECTS OF MANURES.

As all farm manures contain a considerable percentage of organic matter, they have a marked influence in producing a better physical or mechanical condition in the soil to which they are applied. In fact, this value of improving the texture is often far greater than that derived from the plant food supplied.

In another connection it has been pointed out that many farm soils, even those that are unproductive and apparently worn out, contain large amounts of plant food; and that this can be largely *corrected* by improving the mechanical condition or texture.

When manure is incorporated with a soil it greatly improves the texture, loosening a heavy, compact soil, and binding together a light, leachy one, making the soil more friable, warmer, more retentive of moisture, and more congenial to plants in every way. Some experiments conducted by King, at the Wisconsin Station, showed that manured land contained 18 tons more water per acre in the upper foot of soil than similar land unmanured, and 34 tons more in the soil to a depth of three feet. Manure exerts a quicker beneficial influence on the texture of soils than green manures.

Manures will also aid in equalizing the supply and distribution of water in the soils.

Manure will make soils to which they are applied darker in color, and exert a material influence in making soils warmer.

Manured land is less subject to the denuding effects of wind and rain.

CHEMICAL EFFECTS OF MANURES.

Manures act chemically on soils, as already stated, by adding new stores of plant food, and by their decomposition in the soil they give off carbonic acid gas, which unites with the soil waters and increases its dissolving action on mineral plant foods. It also provides the formation of humates in the soil, and thus renders inert mineral plant food more available. The temperature of soils will be materially raised as a result of the chemical actions.

BACTERIAL INFLUENCES OF MANURES.

In addition to supplying plant food and vegetable matter, with their accompanying benefits, farm manures introduce into the soil a variety of bacteria and ferments, which also produce beneficial results. These bacteria, though great in number, have not been studied much in detail, and are little understood. It is very certain, however, that they are helpful in increasing the supply of available plant food. Farm manures have often the advantage over green manures in that the ferments introduced by the manure will result in an alkaline condition of the soil, while that from the green manure will be acid. Hence manure favors the nitrogen-gathering bacteria of legumes and nitrifying organisms.

Professor Chester of the Delaware Experiment Station, has found in a soil that had been liberally manured, and was producing at the rate of six tons of hay per acre several times as many bacteria as were found in the same soil which had little manure, and was producing about one ton of hay per acre.

FACTORS INFLUENCING THE VALUE OF MANURE.

The factors which influence the commercial and agricultural values of stable manures depend upon the following:

(a) The kind of animals.
(b) The age and condition of the animal.
(c) The food of the animal.
(d) The kind and quantity of absorbents used.
(e) The management of the manure.

Each species of domestic animal produces a manure of different quality, and with distinct characteristics. The most marked difference, as noted by its composition, is in the amount of water and organic matter which they contain.

CATTLE MANURE.

Cow or Steer manure contains considerably more water than that from any of our other domestic animals. It ferments and heats slowly, and is ranked as a cold manure. A cow will produce 40 to 50 pounds of dung or solid manure per day, and 20 to 30 pounds of urine or liquid excrement.

A cow fed a balanced ration will void about one-half of the nitrogen in the urine, about one-fourth in the milk, and the balance in the solid excrements.

HORSE MANURE.

Horse manure contains less water than cattle manure, and as the horse has less power to digest cellulose, the manure is more fibrous. Horse manure ferments easily, and hence is called a hot or quick manure. In fermenting, horse manure gives off ammonia or nitrogenous products, and rapidly deteriorates in quality. Because of the rapid fermentation of horse manure, it easily becomes dry and fires. To prevent fire-fanging and loss through fermentation, horse manure, when in piles, should be kept very compact and moist. Mixing horse manure with cow manure will aid in preserving it, and contribute to the value of both for general purposes. The quality of quick fermentation and heating makes horse manure especially valuable for use in hotbeds, mushroom beds and for cold, wet soils. Horse manure is more bulky, or weighs less per cubic foot, than cow manure. A well-fed horse will produce about fifty pounds of manure per day, about one-fourth of which is urine.

HOG MANURE.

Hog manure is a wet, cold manure. It ferments slowly. Its composition varies considerably, depending upon the food consumed. It is much like cow manure in its general characters, but usually much richer. A pig produces 10 to 15 pounds of manure per day.

SHEEP MANURE.

Sheep manure is usually richer and dryer than that from any other domestic animal except poultry. It ferments easily, and is classed as a quick-acting manure, but keeps well when allowed to accumulate in the pens where it is tramped hard by the animals. When placed in piles or composts it is benefited by mixing with cow manure. It is especially valuable for use on flowers or vegetables, when a quick-acting manure is desired. A sheep produces about four pounds of manure per day.

POULTRY MANURE.

Poultry manure is the richest of farm manures, but, like all others, it is variable in composition. It is rich in all the fertilizing elements, but especally so in nitrogen, which is due in part to the fact that the urinary secretions are semi-solid, and voided with the solid excrements. Poultry manure ferments easily, and is quick acting. It loses nitrogen and ammonia very easily, if not properly cared for. It should be kept dry, and if possible also mixed with some absorbent and preservative. Acid Phosphate, phosphate rock, plaster and dry earth are good materials for this purpose. Hard wood ashes, ordinary slaked lime, and such alkaline materials should be avoided, as they will liberate the ammonia, and cause it to be lost. A hen will produce 30 to 40 pounds of manure per year, and a turkey 40 to 60 pounds.

Average Yield and Composition of Fresh Excrements of Farm Animals.

DUNG—SOLID EXCREMENTS.	Excreted per Year.	COMPOSITION.			
		Water.	Nitrogen.	Phosphoric Acid.	Potash Soda.
•	Lbs.	%	%	%	%
1. Cows	20000	84.0	0.30	0.25	0.10
2. Horse	12000	76.0	0.50	0.35	0.30
3. Pigs	1800	80.0	0.60	0.45	0.50
4. Sheep	760	58.0	0.75	0.60	0.30
5. Hen	....	48.6	1.38	0.50	0.41
URINE—LIQUID EXCREMENTS.					
1. Cows	8000	92 0	0.80	Trace.	1.4
2. Horse	3000	89.0	1.20	Trace.	1.5
3. Pigs	1200	97.5	0.30	0.12	0.2
4. Sheep	380	86.5	1.40	0.05	2.0

THE EFFECT OF THE AGE AND CONDITION OF ANIMALS ON THE MANURE.

The quality of manure is materially influenced by the age, condition and uses made of the animal. An animal which is making growth will yield a poorer manure than animals similarly fed that have completed their growth, as the materials for forming bone, muscle, blood, etc., must be extracted from the food. The elements chiefly affected are the nitrogen and phosphoric acid. Animals in poor condition, and being fed for the production of flesh, leave considerable less nitrogen in the manure than those in normal condition. Fattening animals produce a rich manure, as they are at rest and storing almost exclusively fat, which uses very little of the plant food elements.

Animals that are bearing young, or are producing milk, eggs or wool, utilize considerable nitrogen and phosphates and some potash in their production, and the excrements are poorer in plant foods to that extent.

MISCELLANEOUS FARM MANURES.

There are a variety of materials that may be available as manure on many farms, and it is well for farmers to utilize them whenever possible. The ones most commonly met with are described below:

NIGHT-SOIL AND POUDRETTE.

These are terms used to designate human excrements. The name night-soil probably had its origin from the fact that this material is usually handled in towns and cities during the night. The term poudrette has been given to the dried excrements which are manufactured in some places.

In order to use night-soil to any advantage, it is best to compost it with some good absorbent, such as loam, muck or peat. It is estimated that the excrements of a man for one year contains about eleven pounds of nitrogen, two and one-half pounds of phosphoric acid and two pounds of potash.

The night-soil gotten in Baltimore, and used extensively by truckers in that section, and popularly called "soup," contains 2.7 per cent. total solids, 0.28 per cent phosphoric acid, 0.2 per cent. potash and 0.43 per cent. ammonia, and has a value of about $1.50 per ton.

MUCK AND PEAT.

These are names used to designate partially decayed vegetable matter which has accumulated in marshes, swamps and shallow ponds. It is quite variable in composition, generally ranging from one-half to two per cent. of nitrogen, and only traces of phosphoric acid and potash. They are quite valuable for use on sandy soils, and on very stiff clays. The better classes make good bedding and absorbents.

LEAF MOULD.

This is a term applied to a more or less decayed accumulation of leaves in the woods.

It is especially valuable for some special classes of gardening or truck crops. It is costly to gather, and its removal is more or less harmful to the forest trees.

It contains about twenty pounds of nitrogen, three and one-half pounds of phosphoric acid, and five pounds of potash per ton.

SEA WEEDS.

Along the sea border there is considerable quantities of sea weeds washed ashore from time to time, and most of these are fairly rich in plant food, and afford a good source of manure.

They contain from 5 to 12 pounds of nitrogen, two to five pounds of phosphoric acid, six to twelve pounds of potash per ton.

THE INFLUENCE OF THE FOOD OF ANIMALS ON MANURE.

From 50 to 90 per cent. of the fertilizing elements in the food is found in the excrements of animals, depending upon their age and the functions being performed.

Cows in milk return 65 to 75 per cent. of the manurial value of the food, while fattening cattle returns 80 to 90 per cent.

The kind of food that the animal eats has a marked effect upon the richness of the manure. The richer the ration, the richer the manure. From the composition of the more common feeding stuffs, as compiled in the following table, some idea can be gained of the relative influence of feeds on the value of manure.

Fertilizing Ingredients in Common Cattle Food.
Pounds in One Ton.

	Water.	Nitrogen	Phosphoric Acid.	Potash.
GREEN FODDERS				
Corn fodder	1580	8.2	3.0	6.6
Corn silage	1600	8.4	2.6	7.8
Cow peas	1672	5.4	2.0	6.2
Clover	1416	10.6	2.6	9.2
Rye	1532	6.6	3.0	14.6
HAY AND FODDER:				
Corn stover	400	18.4	5.2	24.4
Clover hay	300	40.0	8.2	42.2
Timothy hay	300	23.8	6.6	28.0
Red top hay	188	23.0	7.2	20.4
Orchard grass hay	198	26.2	8.2	37.6
Millet hay	300	24.4	9.2	32.2
Alfalfa hay	168	43.8	10.2	33.6
GRAIN.				
Corn	218	.	14.0	8.0
Oats	180	42.0	13.6	9.6
Barley	218	30.2	15.8	9.6
Wheat	210	47.2	15.8	10.0
Rye	232	35.2	16.4	10.8
MILL PRODUCTS:				
Cotton seed meal	164	134.0	49.4	36.6
Linseed meal	160	116.6	34.0	25.0
Gluten feed	164	74.4	6.8	1.2
Distillers grains	....	96.0	....	....
Malt sprouts	204	71.0	28.6	9.6
Brewers grains	164	72.4	20.6	1.8
Hominy chop	222	32.6	19.6	9.8
Wheat bran	198	47.2	42.0	28.0
Wheat Middlings	204	55.0	25.0	15.0

BEDDING, LITTER OR ABSORBENTS.

Many materials are used for bedding, and these affect the value of the manure.

The objects sought in materials used for bedding are as follows:

1. To make the animals a comfortable bed, and keep them clean.
2. To absorb and retain the urine and watery manure.
3. To dilute and improve the mechanical condition of the manure, and make it easier to handle.

The materials used for bedding are generally not rich in fertilizing constituents, and to some extent tend to dilute the manure; but as they absorb and hold the valuable liquid parts, which are easily lost, they really improve the quality.

Straw is the most universal bedding material in use, and it fulfills most of the requirements very satisfactorily. It is abundant on most farms, as it is in a measure a waste or by-product, and has no market. There are many other materials that have better absorbent powers than straw, and are relatively cheaper when bedding must be purchased.

Dust Absorbents.—In order to help absorb liquid manures, and prevent the loss of volatile ammonia compounds, dust absorbents are used. Good materials for use in this way are land plaster (gypsum), kainit, finely ground phosphate rock and phosphate, fine earth and sand.

The use of such materials as furnish phosphoric acid and potash are especially valuable, as they enrich the manure in these plant foods.

The following table gives the materials most commonly used for bedding, with their composition and relative water-absorbing power:

	FERTILIZING CONSTITUENTS IN ONE TON.			
	Nitrogen.	Phosphoric Acid.	Potash.	Water absorbed by 100 lbs.
	Lbs.	Lbs.	Lbs.	%
Wheat Straw	9.6	4.4	16.8	220
Rye Straw	11.2	5.1	18.1	....
Barley Straw	11.4	5.0	23.5	....
Oat Straw	14.4	3.6	23.0	....
March Hay	....	....	....	....
Corn Fodder (final cut)	17.2	10.6	54.0	250
Peat	20.0	....	....	600
Sawdust	4.0	6.0	14.0	435
Leaves	15.0	3.2	6.0	162
Spent Tan Bark	15.0	....	....	450

Experiments conducted by the Maryland Experiment Station (Bulletin No. 104), on bedding, give some results that are interesting in this connection.

Absorptive Properties and Relative Cost of different Bedding Materials.

MATERIAL.	Water absorbed per pound of Bedding.	Pounds of Bedding required to absorbliquid manure from 1 Cow 16 hours.	Pounds of Bedding required to absorb for 24 hours.	Yearly cost for Cow stabled 16 hours per Day.	Yearly cost for Cow stabled 24 hours per Day.
Cut Stover....	2.5 Lbs.	2.8 Lbs.	4.0 Lbs.	$2.55	$3.65
Cut Wheat Straw.......	2.0 "	3.3 "	5.0 "	3.61	4.82
Uncut Wheat Straw.......	2.0 "	3.3 "	5.0 "	3.11	4.15
Sawdust.......	0.8 "	3.3 "	12.5 "	.11	.45
Shavings......	2.2 "	3.0 "	4.4 "	3.28	4.81

The prices assumed in the table for these different materials would, of course, vary considerably in different seasons and different localities. The cut stover was valued at $5.00 per ton, the uncut straw at $5.00 per ton, the sawdust at 20 cents per ton, and the shavings at $6.00 per ton. It costs about one dollar per ton to cut straw, and a little less to cut the stover. Stover uncut was valued at $4.00 per ton. These were about the relative values on the farm, basing the calculation on the selling price in this section. It will be seen that at the relative prices given cut stover was much more economical than was the uncut straw, and the uncut straw more economical than the cut straw. The shavings cost practically the same as the cut straw. But the shavings were so much more satisfactory, in every other way, that they would more than compensate for the extra cost. Especially is this true where any effort is being made to produce first-class milk.

The relative cost of the sawdust presents an interesting feature. This sawdust was purchased from a nearby sawmill, and the cost assumed for the calculations given was the price paid at the mill—twenty-five cents per load. It might have been well to consider the cost of hauling, which was fifty cents per load. Even this could have been added to the assumed price, and still made the sawdust by far the cheapest bedding used. Then, too, as was emphasized before, the sawdust was ideal for this purpose. The conclusion is evident that wherever sawdust can be obtained it would pay to use it for bedding. This would be true even when plenty of corn stover or straw was at hand, for the straw and the stover could be sold, and money saved in buying the sawdust.

WASTE OF MANURE.

Even though manure is regarded highly by all farmers in sections where fertilizers are needed, nevertheless there is probably no product of equal value which is so much neglected and so poorly cared for.

The first great source of loss is through the incomplete absorption of the urine. It is not infrequent to see no attempt being made to save this portion of the manure. When it is remembered that the urine is richer in both nitrogen and potash than the dung, and that they are more available to crops in the urine than in the dung, it should be self-evident to all that it is highly essential that this part of the manure be carefully saved.

The second greatest source of waste of manure is the loss incurred by leaching. If manure is piled against the side of the stable where the water from the roof can drip on it, or if it is piled on the hillside, or other exposed places, the rain water in leaching through the manure washes out of it much nitrogen and potash, which is seen in the dark-brown liquid oozing from the base of the pile.

The third common source of loss is that incurred by heating and fermenting. When manure is thrown in piles it soon heats and throws off more or less vapor and gas. This heating is caused by fermenting or breaking down of the materials composing the manure. The fermentation is caused by the action of bacteria or low orders of microscopic plants. The bacteria which produces the most rapid fermentation in manure need plenty of air or oxygen. Therefore, fermentation will be more rapid in loosely piled manure. A certain amount of moisture is necessary for fermentation, but if the manure is wet fermentation is checked, because it lowers the temperature, and excludes part of the supply of air. The fermentation which takes place in manure breaks down the organic matters, and cause a loss of humus, and also of nitrogen through the ammonium compounds, which are volatilized. The odor of ammonia, which is commonly noticeable about horse stables and piles of horse manure, is an evidence of the fermentation and loss which is taking place.

Fresh manure loses in the process of decay from 20 to 70 per cent. of its original weight. An 80 ton heap of cow manure left exposed for one year lost 66 per cent. of its dry substance. Some tests conducted by the Cornell Experiment Station showed that 2 tons of horse manure exposed in a pile for five months lost 57 per cent. of its gross weight, 60 per cent. of its nitrogen, 47 per cent. of its phosphoric acid and 76 per cent. of its potash. Five tons of cow manure exposed for the same length of time in a compact pile lost 49 per cent. of its gross weight, 41 per cent of its nitrogen, 19 per cent. of its phosphoric acid and 8 per cent. of its potash.

While manure may lose a large per cent. of their valuable constituents, yet they may be worth more per ton than they were before the loss occurred; because the plant foods remaining are concentrated into a less quantity of material.

CARE OF MANURE.

The first step to be taken in the care of manure so as to prevent the losses mentioned above is to provide sufficient bedding or litter in the stable to absorb and save all the liquid parts. The losses due to fermentation can be greatly checked by mixing horse manure with the older cow manure, by making the piles compact so as to exclude the air and by moistening the pile so as to assist in excluding the air and also to lower the temperature. The use of chemical or mechanical absorbents such as paste, kainit, phosphate rock, etc., in the stable and sprinkled over the manure assists in preserving the manure and preventing loss. Losses from washing or leaching by rain may be prevented by piling under cover or in favorable basin like places, or still better by hauling it directly to the field and spreading it as soon as produced.

APPLICATION OF MANURE.

In order to reduce the loss in manure to a minimum, and also to economize in handling it, the general aim and practice should be to haul it directly from the stable to the field and spread it at once. On the average farm the following of this practice all through the year would result in less loss than any method that could be pursued.

The use of rotted manure rather than fresh manure is desirable in connection with many market garden or vegetable crops, as it gives quicker results and with root crops will give a smoother and nicer product.

Manure should be spread as soon as it is hauled to the field. The practice of putting it in piles is objectionable because of the loss that is likely to occur. The placing in piles also involves additional labor.

The manner of spreading will depend upon local conditions, but where the distance to haul is relatively short and it is desired to have it evenly spread the manure spreaders will be found serviceable machines.

From 10 to 20 tons of manure per acre is usually considered a fair application; but considerable more is frequently applied for market garden crops. Experiments have shown that generally it would be far more profitable to use about one-half the usual quantities and to supplement it with commercial fertilizers.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 123. NOVEMBER, 1907.

SPRAYING FOR SAN JOSE SCALE.

By T. B. Symons and G. P. Weldon.

INTRODUCTION.

The importance of properly treating orchard trees for control of the San Jose Scale and other injurious insects, has been so thoroughly brought to the attention of orchardists during the last few years that there can be no excuse for a grower to allow his trees to be severely injured or killed by them. All observing and up-to-date orchardists know well enough the necessity of treatment for insect enemies of fruit trees, and they are realizing more and more that the commercial buyer seeks, and is willing to pay more for fruit which has been given the best of attention. There is plenty of evidence to convince even the most unreasonable man that his trees must be given this attention, not only to save them, but in order that he may secure a fair return for capital invested.

The San Jose Scale is present on a large majority of fruit trees in the towns and cities of the State, as well as in orchards. Because of this fact, the Department inaugurated the plan of conducting public sprayers. The policy has been to make this work self-supporting by charging the owners so much per tree, to cover the cost of labor and the materials used. This work was commenced on a small scale last spring, and proved very satisfactory. It was found that in the towns and cities all owners of trees would gladly pay a reasonable amount to have their trees properly treated, but they could not afford, in many cases, to do this work themselves, and in still others would not take the trouble. This phase of the work proved an innovation, and it is believed that it is the first instance of a State Department conducting public sprayers. A more elaborate discussion of their operation will follow in this bulletin.

In giving the report of the work with the San Jose Scale, during the past year, it will be seen that the results of the experiments more thoroughly substantiate the previous recommendations. In addition they give to the orchardists of the State up-to-date information as to the effectiveness of the various insecticides employed in the control of the San Jose Scale. It is necessary, in order to be able to answer inquiries intelligently, to determine the efficacy of all new washes on the market, and compare it with that of the standard remedies. The Station is always pleased to co-operate with manufacturers in testing any new remedy, but its recommendations will be based on the effectiveness, as shown by actual results, irrespective of the published claims of the manufacturer.

It seems desirable to reiterate the statements made in Bulletin No. 112 that when an orchardist wishes to try a new insecticide for the control of any pest, which already has a known remedy, that he use such new remedy on a few trees at first. Remedies which have proved efficient often present some undesirable features. These undesirable features the experimenter hopes to find eliminated in the new one. Whether or not they will, can only be determined by a careful comparison of results obtained from using both the standard and the new.

STATUS OF SAN JOSE SCALE IN STATE.

The reports of our local inspectors during the past year indicated a great increase in the number of orchardists spraying, and the desire on the part of growers for more information along these lines. In many parts of the State the pest is looked upon as a benefit to the orchard industry, due to the fact that better care of trees is necessitated. In other parts it is hardly recognized, and therefore is doing considerable injury. More new territory has been covered by the local inspectors the past year than ever before, and it is hoped that in these parts the efforts expended on behalf of the growers, will be evidenced by better attention to trees and better fruit.

It seems necessary to again warn the orchardists of the State in regard to the distribution of the San Jose Scale from the Osage Orange Hedges, which stand as a menace in many localities, as they are invariably infested. All such hedges should either be destroyed, or thoroughly and regularly treated with an effective remedy. The inspection and enforcement of the State Horticultural Law has been conducted as vigorously as means would permit, and it is believed that conditions are steadily improving in all parts of the State which have been visited by the inspectors.

EXPERIMENTS.

In experimenting with patent insecticides, manufactured for the control of San Jose Scale, there are several essential points that must be taken into consideration, in order that results will be indicative of the true worth of the materials used. Most important of all is the selection of the orchard. Trees in an experimental orchard should be very badly infested with scale. This is absolutely necessary for a proper test. It is known from years of experience with the lime and sulfur wash that it will give satisfactory results, if the vitality of trees is not too low as a result of the scales' attack. The only way to judge of the efficiency of the patent preparations is by a comparison of the good accomplished by their use, with that accomplished by the use of lime and sulfur under the same conditions. Not only should trees in the experimental orchard be badly infested with scale, but, on the other hand, they should receive the cultivation necessary to keep trees growing, and in a healthy condition. The ideal orchard for an experiment is one in which these two features are combined. Needless to say, such an orchard is hard to find, for the person who carefully tills and looks after the soil conditions of his orchard will also spray to prevent injury from insect attack. An orchard poorly kept, and grown up with weeds, is unsatisfactory. Often when very scaley trees are sprayed they are low in vitality, and even though the spray may be entirely successful in killing the insects, the trees will not recover. The question now arises, was the tree killed by the spraying mixture, by the scale, or by poor treatment of soil, or by a combination of all these causes?

The orchard being selected, care should be exercised in mixing the insecticides, so that they do not separate out, but maintain a thorough and uniform mixture. The correct proportions should also be carefully measured, so that the proper strength to use may be accurately determined. Spraying should be done thoroughly, and every part of the tree should be covered.

For the experiments recorded in this bulletin two orchards were selected, one belonging to Mr. Frank W. Hill, of Upper Marlboro; the other to Mr. J. P. Ford, of Boonsboro. Thanks are due these gentlemen, who kindly aided in every way, so that the work might be carried to a successful termination.

The trees were all very badly infested, as none had received treatment the previous year. Mr. Hill's orchard was sprayed in the Fall; Mr. Ford's in the Spring—the former November 23, 1906, the latter April 4 and 5, 1907. The weather at the time of spraying Mr. Hill's orchard was dry, but very windy, which made it exceedingly difficult to thoroughly cover a tree without great waste of materials. The trees had not been trimmed, and were very full of a growth of slender branches, which fact also added to the difficulty in doing thorough work. Three different strengths of each petroleum insecticide were used, viz: The recommended strength of one gallon of the mixture to 20 of water; double this strength, or one gallon of the mixture to 10 of water, and one gallon of the mixture to 15 of water. Rex brand lime and sulfur was used, at the strength of one gallon of the mixture to 10 gallons of water.

Mr. Ford's orchard was sprayed a trifle late in the season, and much injury to buds resulted, and in a few cases to the whole tree. These trees were just coming into bloom, and should have been sprayed at least a week earlier in the season. The fact that the fall spraying of Mr. Hill's orchard did not injure a single tree, would seem to indicate that injury to Mr. Ford's trees was due to the lateness of the spraying, and not to the kind of insecticides used. Some of the trees were, however, very badly encrusted with scale, and evidently did not have enough vitality left to bring about recovery, even though the scale was all killed. The soluble oils applied to this orchard were all used at three different strengths, viz: one gallon to 10 of water, 1-15 and 1-20. Rex brand lime and sulfur was used in two strengths, 1-9 and 1-10; Salamine in two strengths, 1-15 and 1-20; Lion brand California wash in one strength, 1-25. Lime and sulfur made according to the formula recommended in this bulletin was also used on a number of the trees.

Each orchard was examined twice after spraying, and the results of each mixture carefully noted. Mr. Hill's orchard was examined April 18 and October 15. Mr. Ford's was examined July 12 and October 18.

RESULTS.

KIL-O-SCALE, 1 gallon to ten of water.

Forty-nine trees were treated. Boonsboro orchard, 38 peach; Marlboro orchard, seven apple and four peach.

General results were good. A few scales bred on all trees, but in no case did they develop in sufficient numbers to do the trees any injury for the season. Some injury to the trees at Boonsboro was caused by this strength of the mixture.

KIL-O-SCALE, 1-15.

Thirty-eight trees were treated with this strength, all of them at Boonsboro. Results were good. Very little scale bred during the summer, and with the exception of slight injury to the trees from spray, results were satisfactory.

KIL-O-SCALE, 1-20.

Thirty-seven trees were treated. Boonsboro orchard, 24 peach; Marlboro orchard, 13 peach.

Although good was accomplished with KIL-O-SCALE at this strength, on the whole it was unsatisfactory. Much more scale bred than where the higher strengths were used. Three trees in the row sprayed at Marlboro, with this strength, were left for checks. These were covered with live scale, and were not nearly so thrifty as the sprayed trees in the row. It only needed a casual glance to convince one that the spraying had done some good, though not enough to be considered satisfactory.

TARGET BRAND, 1-10.

Forty-four trees were treated. Boonsboro orchard, 32 peach, Marlboro orchard, five apple and seven peach.

This mixture gave good results on the Marlboro orchard, with the exception of one apple tree, upon which the scale had bred freely. At Boonsboro general results were good. Only a few scales had bred on each tree. Many trees were quite severely injured, but none killed.

TARGET BRAND, 1-15.

Thirty-four trees were treated, all at Boonsboro. Results about the same as above. Slight injury was noticed on many of these trees.

TARGET BRAND, 1-20.

Thirty-five trees were treated. Boonsboro orchard, 24 peach; Marlboro orchard, 11 peach.

More good resulted from this strength at Marlboro than at Boonsboro. At the former place very little scale had bred during the summer; at the latter place it had bred quite freely. One large tree in the Boonsboro experiment was killed, apparently by the spray, and others quite severely injured. It could not be determined why the weaker strength of this mixture should have done more damage to the trees than the stronger, but such seemed to have been the case.

SCALECIDE, 1-10.

Fifty-seven trees were treated. Boonsboro orchard, 45 peach: Marlboro orchard, 12 peach.

The Marlboro orchard showed better results than did the one at Boonsboro. The trees in the former made an excellent growth, and very little live scale could be found, except upon one tree. These seemed to be confined principally to one branch, which had probably been missed in the spraying of tree. Final examination at Boonsboro revealed just fair results. Scale had bred more or less on all trees sprayed.

SCALECIDE, 1-15.

Forty peach trees were treated at Boonsboro.

Results were fair. Scale had bred about the same as in above experiment.

SCALECIDE, 1-20.

Twenty-seven trees were treated. Boonsboro orchard, 20 peach; Marlboro orchard, three peach and four apple.

Fair results in Marlboro orchard, good on peach and poor on apple. At Boonsboro scale had bred freely on all trees. Much good was accomplished, but in general results were unsatisfactory.

SOLUBLE PETROLEUM, 1-10.

Fifty-one trees were treated. Boonsboro orchard, 37 peach; Marlboro orchard, nine peach and five apple.

This mixture proved very satisfactory on both orchards. A careful examination of trees failed to reveal the presence of live scale, except in very small numbers. Trees in the Marlboro orchard sprayed with both strengths were very thrifty, and had made an excellent growth, though they were very scaly at the time of treatment.

SOLUBLE PETROLEUM, 1-15.

Forty peach trees were treated at Boonsboro.

Somewhat more live scale was found than where the higher strengths were used. General results were good.

SOLUBLE PETROLEUM, 1-20.

Thirty-four trees were treated. Boonsboro orchard, 20 peach; Marlboro orchard, 14 peach.

As stated above, the trees at Marlboro that were sprayed with this strength were thrifty, only a few scale having bred upon them. This strength was not satisfactory on the Boonsboro orchard. Much more scale bred upon these trees than where the higher strengths were used.

REX LIME AND SULFUR, 1-9.

Approximately 100 peach trees sprayed at Boonsboro.

Next to lime and sulfur, made according to the ordinary formula, this mixture proved more satisfactory than any other, with the possible exception of the soluble petroleum. Trees sprayed on April 5 were still quite white with the lime when examined on October 18. Scarcely any scale had bred. Before spraying some of the trees were almost dead, so bad was the scale. Nearly all revived after the spraying.

REX LIME AND SULFUR, 1-10.

Thirty trees were treated. Boonsboro orchard, 20 peach; Marlboro orchard, 10 peach.

This strength proved equally as satisfactory as the other. All trees sprayed with Rex Lime and Sulfur were in good condition, as regards scale.

SALAMINE, 1-15.

Thirty-five peach trees were treated at Boonsboro.

No good accomplished. Scale bred as freely as though no spray had been applied. This experience with this mixture was the same as that reported by several orchardists in other parts of the State. Upon examination of a couple of these orchards they were found to be in no better condition than before the application was made.

SALAMINE, 1-20.

Forty-eight peach trees were treated at Boonsboro. Same results as above.

LION BRAND CALIFORNIA WASH, 1-25.

Forty-eight peach trees were treated at Boonsboro.

This mixture also proved unsatisfactory. Apparently no good was accomplished from its application.

LIME AND SULFUR, Regular formula.

About 200 trees were sprayed at Boonsboro. The usual good results of this wash were apparent here. Very little scale had bred; much less than on trees treated with the other washes.

CHECK TREES.

Boonsboro orchard, eight; Marlboro orchard, four.

All check trees contained a large amount of live scale, which had bred freely throughout the summer. The only trees upon which as much was found were those that were sprayed with Salamine and Lion Brand California Wash. All others showed results of the spraying.

SUMMARY.

With the exception of Salamine and Lion Brand California Wash, good was accomplished with all mixtures. In no case did a petroleum mixture prove so unsatisfactory that it should be condemned for general use. On the other hand, results were such that they could be recommended as partially satisfactory, at least.

These experiments confirm results of previous ones carried on by this Department, that the recommended strengths of many patent insecticides are not strong enough to do the work in a thorough manner. Hence, when used they should be at least a third stronger than is usually recommended by the manufacturer.

It is doubtful whether anyone would be justified in giving up the lime and sulfur wash for any of these patent remedies, for its superiority is unquestionable, and it is certainly the most economical.

TABULATED SUMMARY OF RESULTS.

Insecticide Used.	trength.	Number f Trees Sprayed.	Injury.	Results in Killing Scale.
Kil-o-Scale.........	1-10	49	Slight	Good
Kil-o-Scale.........	1-15	38	Slight	Good
Kil-o-Scale.........	1-20	37	None	Unsatisfactory
Target Brand......	1-10	44	Severe	Good
Target Brand......	1-15	34	Slight	Good
Target Brand......	1-20	35	Severe	Fair
Scalecide	1-10	57	None	Fair
Scalecide	1-15	40	None	Fair
Scalecide	1-20	27	None	Fair
Sol. Petroleum	1-10	51	None	Very Good
Sol. Petroleum.....	1-15	40	None	Good
Sol. Petroleum.....	1-20	34	None	Fair
Rex Lime & Sulfur.	1-9	100	None	Very Good
Rex Lime & Sulfur.	1-10	30	None	Very Good
Salamine	1-15	35	None	Very Poor
Salamine	1-20	48	None	Very Poor
Lion Brand Cal. Wash	1-25	48	None	Very Poor
Lime and Sulfur...	Regular formula	200	None	Very Good
Check Trees.......		8		Very Scaly
Total trees in experiment.........	....	955		

DIRECTIONS FOR MAKING LIME SULFUR WASH.

We continue to recommend the Lime Sulfur Wash as the most efficient, economical and satisfactory remedy for the San Jose Scale. For the benefit of those persons who are not as yet familiar with its use, it is deemed advisable to again give what is considered the best formula and method of making. There is considerable latitude in the quantity of materials used, and in the manner of making the mixture within which uniformly good results may be obtained. These points were thoroughly discussed in Bulletin 112, issued last Fall. It is only necessary to say here that the materials can be boiled in a home-made vat, or hog scalder, or if steam is desired, in a small boiler, such as is shown in Figure 1. This type of boiler was used with the public sprayer. A regular steam engine can be employed where it is desired to make the wash on a large scale.

It may also be well to repeat that there is practically no difference in the use of flour or flowers of sulfur in making the wash, and as the flour of sulfur is the cheaper, it would seem more practical to employ this grade.

FORMULA:

Stone Lime	20 lbs.
Flowers or flour of sulfur	15 lbs.
Water to make	50 gals.

DIRECTIONS:—Put twenty gallons of water in an iron vat, or hog scalder, and bring to a boil; then add the stone lime and sulfur. The sulfur should be made into a paste, with hot or cold water, before placing it in the boiler, in order to facilitate its mixing. After the lime and sulfur have been boiled for some time, salt* may be added, if desired. Boil the mixture, stirring occasionally, from thirty minutes to one hour, or until the sulfur is thoroughly dissolved, and a clear, amber-colored solution produced. Then dilute by adding sufficient hot or cold water to make fifty gallons. Pass the mixture through a strainer, with at least twenty meshes to the inch, into the spray barrel, and apply to the trees warm.

TIME OF APPLICATION.

No particular difference has been observed in the effectiveness of the lime sulfur wash, whether applied in the Fall or early Spring, during the dormant season. It is believed, however, that early Spring is the best time to spray, as the mixture will remain on the trees for a longer period during the summer, when the scale is breeding, and this is desirable. In some cases, where there is a great amount of spraying to be done, it may be necessary to do a part of it in the late Fall, as

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*NOTE:—While salt is not a necessary ingredient of the wash, ten pounds can be used, if desired.

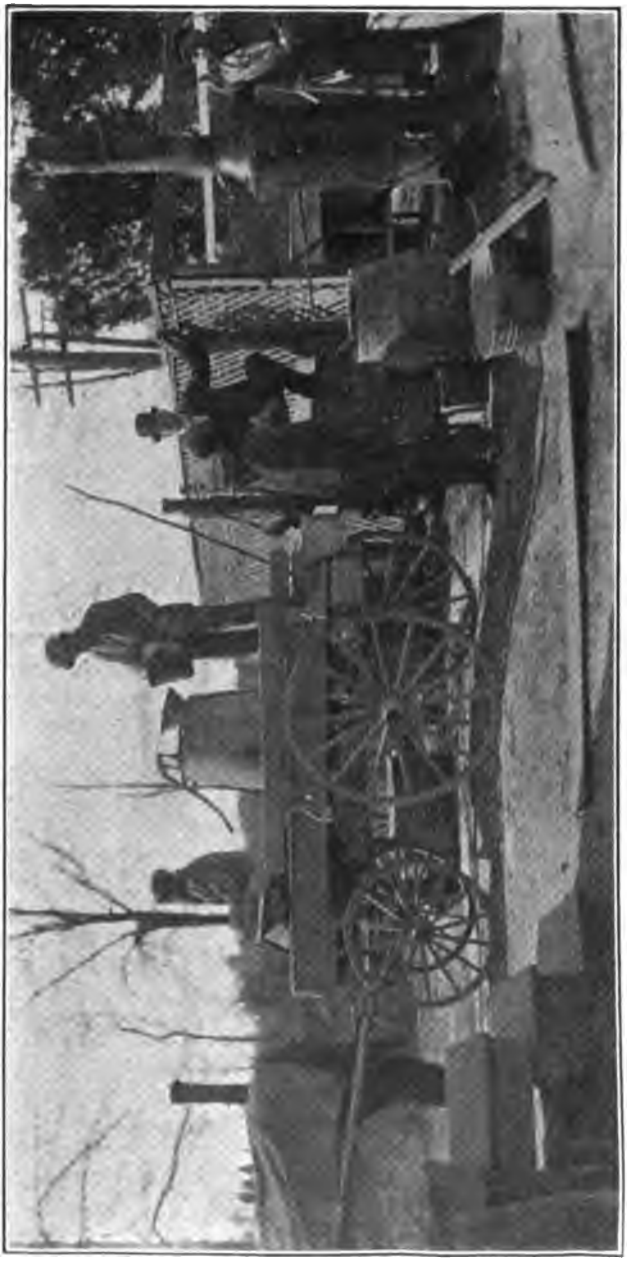

Figure 1.—Showing small boiler used to boil lime-sulfur wash for public sprayer.

often in the Spring weather conditions prevent an extended period for the work, and other Spring work may interfere. It is safe to say that 90 per cent. of the spraying in Maryland is done in the Spring, and there is little doubt but that period is preferable. It must be borne in mind that the lime sulfur wash is a treatment for dormant trees, and should not be applied after the buds open in the Spring.

MODE OF APPLICATION.

No matter how good the materials used, or how well the wash is made, if the spraying is not done thoroughly the results will be disappointing. Too much stress cannot be made upon this important phase of the work. One of the advantages of the lime sulfur wash is that after the spray has dried on a tree the twigs or limbs that have been missed are easily seen. Such trees should be gone over a second time. Especially should the terminal parts be thoroughly covered, as the young insects always seek the new, tender wood.

If a few infested trees have been found in an orchard, spray the whole orchard. The pest is always more thoroughly distributed than an inspection would ordinarily indicate.

In the selection of a pump for spraying purposes, the particular size, etc., is left to the judgment of the orchardist. The majority of the pumps on the market will give satisfaction, and conditions under which spraying is done are so varied that only general recommendations could be made. There is no doubt that the ordinary barrel pump is more generally used than other kinds, but the power sprayers and double-acting pumps have their place, where there is a large amount of work to be accomplished.

Spraying, at best, with any insecticide or fungicide, is rather disagreeable work, and the sprayman should be fitted out with rubber or oilskin coat, hat and gloves. It is also a good plan to rub vaseline on the hands and face to prevent the spray from irritating the flesh. Make it a point to have a sufficient length of hose—twenty feet to each lead should be the minimum length for orchard work. This will enable the spraymen to go all around an ordinary-sized tree without moving team. Good extension rods are necessary, and will aid him in keeping out of the spray. What is stated above in regard to the different pumps may also be said of the different nozzles on the market. Some prefer the fan-shaped, others a conical spray.

In conclusion, select the best apparatus suited to one's needs, and conduct the work in a thorough manner.

The following are manufacturers and dealers in pumps and supplies:

Griffith & Turner Co., Baltimore, Maryland.
Goulds Manufacturing Co.. Seneca Falls, New York.
The Deming Co., Salem, Ohio.
Morril & Morley. Benton Harbor, Michigan.
Field Force Pump Co.. Elmira, New York.

Myers Pump Co., Ashland, Ohio.
George H. Stahl, Quincy, Illinois.
Spray Motor Co., Buffalo, New York.
L. G. Orndorff, No. 203 Seventh St., Washington, D. C.
F. W. Bolgiano & Co., No. 935 M St., N. W., Washington, D. C.

SUMMER TREATMENT.

When a serious infestation is observed during the summer months, and treatment is desired to hold the pest in check until the dormant period, 20 per cent. Kerosene Emulsion, applied on sunny days, will serve to kill the crawling young, and many of those scales recently settled. This treatment only serves as temporary relief, or until the regular dormant washes can be applied.

The following method is used in making the emulsion:

Water—five gallons.
Ordinary hard soap—one and one-half pounds.
Kerosene—ten gallons.

Pour the ten gallons of kerosene into a spray barrel. Dissolve the soap in the five gallons of boiling water, and pour soapy water, while hot, into the barrel, with the kerosene. Emulsify by pumping the mixture back into itself for at least fifteen minutes. Add thirty-five gallons of cold water, and the mixture is ready to apply.

If Tak-a-Nap Soap can be secured, the Emulsion can be made as above, using ten pounds of the soap without heating the water.

OPERATION OF PUBLIC SPRAYERS.

For several years it has been the aim of the Department to encourage private enterprise in the establishment of public sprayers, to be used in small orchards and villages. It has also been the aim to impress on all commercial orchardists the desirability of their owning and operating their own pumps. As a rule, the farmers and orchardists throughout the State have found the owning of a barrel pump a necessity for the proper treatment, not only of orchard trees, but also of other crops, as well as being useful in whitewashing and the disinfection of stables, poultry-houses, etc. While some public sprayers have been conducted from time to time, mostly in the large orchard districts, the business has not proved to be attractive, or a financial success. The failure has generally been due to a want of proper equipment. It has been apparent for some time that in order to induce residents of towns and cities to effectively treat their fruit and shade trees, invariably infested with San Jose Scale, and other pernicious insects, there must be a means whereby they can have this work done at a reasonable cost, and with little trouble. It is the rule that such men are engaged in business, which does not permit their giving time to home matters of this nature, even if they had the inclination, and could afford to procure the necessary apparatus for the proper conduct of this work.

With a view to demonstrating to the public that such a business can be conducted successfully, this department, upon approval of the Board of Trustees, established three public sprayers, locating them in different parts of the State, viz., Prince George, Frederick and Talbot Counties. As stated previously, the idea was to make them self-supporting, by charging so much per tree to cover the actual cost of operation. As was anticipated, the greatest difficulty in their operation was to secure efficient labor. This phase of the problem proved serious in conducting the work in Frederick County, which, owing to circumstances, could not be given personal attention. In order to give a description of the work accomplished by the use of these sprayers, it will suffice to discuss one at length.

WORK IN PRINCE GEORGE COUNTY.

The continued requests for the service of a public sprayer in this locality prompted the Department to locate one sprayer here. The fact that this territory was close at hand was also an advantage. The lime sulfur wash was employed in all the work. If any of the so-called patent washes prove entirely satisfactory they could be used in such work with much more advantage, as it would obviate the necessity of cooking, which must be done with the lime sulfur wash. The aim in locating a sprayer in this vicinity was to spray all trees in the towns along the Baltimore and Ohio Railroad between Hyattsville and Laurel. This was practically accomplished. The outfit was placed in charge of Mr. W. C. Traverse, who solicited the work, and superintended the operations of the apparatus and men, with satisfaction.

Owing to the delay in securing the barrel pump and the small boiler which was used in making the solution, actual spraying did not commence until March 26. From that time until April 25, when the buds had advanced so that it was inadvisable to continue longer, spraying was done every day except when interrupted by unfavorable weather. In all, forty-five places were visited, and about 2,500 trees treated.

Of course, much time was taken up in moving from place to place, and on some days more time was occupied in this way than in spraying. The boiler and stock of materials were located in a central place in the town, where the solution was made. It was hoped that a charge of five cents per tree would cover all expenses, but the charge of $3.00 per day for horse and cart, an average of $6.67 per day for labor, cost of materials used, general wear on apparatus, also the loss of time in moving, as many citizens had such a small number of trees, made it necessary to increase this amount to ten cents per tree in order to make the work self-supporting. These expenses were exceptionally high, however, and it is thought that with better arrangements and the benefit of the past season's experience, the charge can be much reduced. The cost will lessen as the number of trees increases. Not a single complaint was made, however, upon the rate of ten cents per

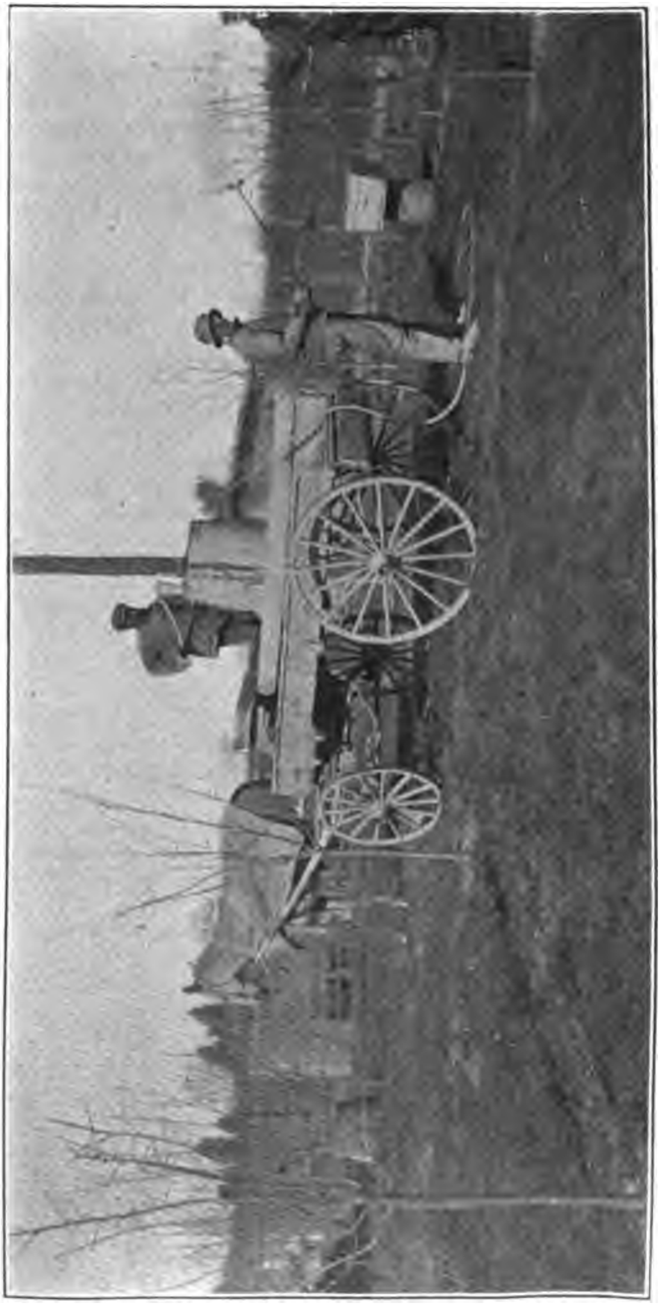

Figure 2.—Spraying in a back-yard orchard by the public sprayer.

tree, as this was very much less than if each owner had done the work himself, with a small outfit.

It was found in Hyattsville, after the spraying was in progress, that many persons were anxious to have their trees treated. Not only fruit trees, but also shade trees, hedges, shrubbery, etc., were treated, when desired. The public sprayer did good work in this locality, affording means for the treatment of many trees that would otherwise have died, or stood as a menace to the neighborhood by distributing the pest to other trees. Cuts Nos. 1 and 2 show different views of this sprayer at work.

The outfit established in Talbot county, under the supervision of Mr. J. E. Aaronson, proved equally as successful. The one in Frederick, after two weeks' work, was abandoned, on account of labor conditions.

It is the intention of the Department to establish more of these outfits, as funds will permit, in appropriate localities in Maryland, especially where they can work in small towns and cities. It is believed that the only way in which all citizens can be induced to have their trees sprayed is to furnish means whereby they can have it done. In some cases, where the territory justifies it, the work may be conducted in both Fall and Spring.

THE PEACH LECANIUM OR TERRAPIN SCALE.

Eulecanium nigro-fasciatum, Perg.

By

A. B. GAHAN.

This scale was for many years confounded by American entomologists with the European scale, *Eulecanium persicae,* Fabr., and for that reason the early history of the species is badly confused. It was not until 1898 that Mr. Theo. Pergande first established its separate identity, and gave to the new species the name of *Eulecanium nigro-fasciatum.* He established the fact that it was a native of the Eastern United States, and located its original habitat in the region between New York and Washington, D. C. The pest is now found in all of the States east of the Mississippi river, and in a number of the Western States as well. Since it is indigenous to Maryland, it is not surprising to find this scale present in all parts of the State in greater or less abundance. It seems, however, to be more prevalent in the mountain districts of the Western part of the State than in the tidewater counties. The majority of the complaints recently received regarding it have come from Washington and Frederick counties, but its presence has been noted in several other localities, particularly Kent and Prince George's counties.

Although nominally an enemy of the peach, the Terrapin scale does not confine itself to that fruit tree, but is likewise injurious to the maple and plum, and it is said to also infest apple, linden, birch, sycamore, poplar and blueberry. No extended survey of the State has been made to determine the relative importance as a host plant of these different species of trees, but the greater part of the damage done by it is undoubtedly to peach orchards. One instance of severe injury to maple shade trees came to our notice the past season, through correspondence with Mr. John Diehl, of Johnsville, Frederick county, who sent species of the scale on red maple, and reported that the trees were being badly injured. A severe infestation of plum trees was observed in a plum orchard on the College farm in 1906, and specimens on plum are occasionally received from correspondents for identification. Beyond a few scattered specimens on an apple tree that stood in the midst of a very badly infested peach orchard, the writer has never observed this scale upon other hosts than the plum, peach and maple, and it is probable that these are the only hosts of any importance in this State.

NATURE OF THE INJURY.

The injury caused by this scale is different in some respects from that caused by the San Jose or Chinese scale, and most other similar pests. While the drain upon the strength of the tree caused by the sucking up of its sap by the insects cannot be otherwise than detrimental, it is, nevertheless, rarely ever sufficient to cause the death of the tree. The young growth is frequently stunted, and sometimes killed. The scale infests chiefly the twigs and smaller branches of trees that are full grown, leaving the trunk and larger limbs practically unmolested, and this fact may account, to some extent, for the escape of the tree from destruction, enough vigor being retained in the trunk and large branches to overcome the loss from the twigs.

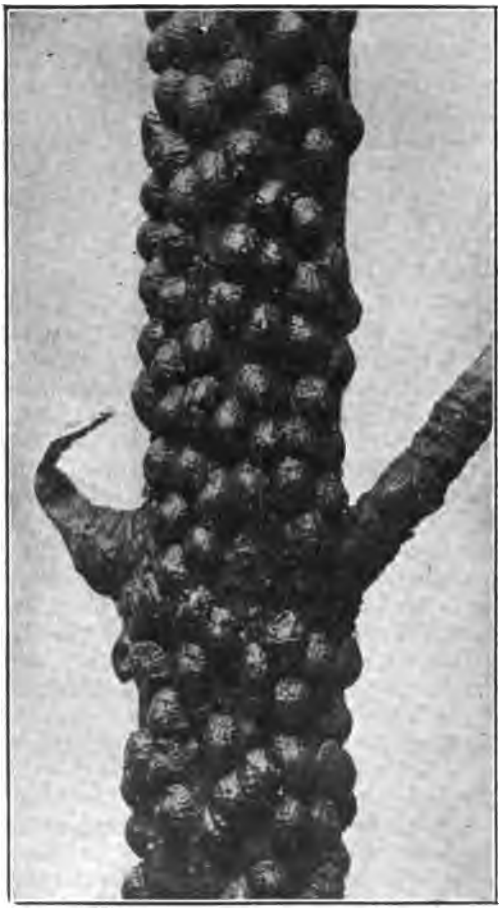

Figure 3.—Adult females of the Terrapin Scale on a peach twig. After Sanders, U. S. Dept. of Agri., Bureau of Ent.; Cir. Bul. 88.

The principal loss then to the orchardists from this pest is through the damaging of the fruit. Large quantities of honey-dew are secreted by the female insects, and this collects upon the leaves, twigs and fruit, covering them with a sticky coating. This honey-dew acts as host for a black fungus, which renders the fruit from an infested tree dirty and repulsive-looking, and consequently unsalable. So plentiful is this fungus growth at times that it gives the whole trees the appearance of having been sprinkled with soot.

DESCRIPTION AND LIFE HISTORY.

The Terrapin scale gets its popular name from its shape, which is not unlike that of a small terrapin. It hibernates as an immature female, and is most often seen in that form. At this stage it is a small, hemispherical object, about two mm. in length, and slightly less in width, with an orange red patch on the back, and darker streaks radiating toward the sides. The back is slightly flattened, and the sides more or less corrugated or ridged. The size increases and the color changes as the females advance in age, so that when full grown they are about three mm. in length, of a nearly uniform reddish-brown color, very convex, and slightly flaring at the sides. After oviposition the empty scale often becomes grayish.

The hibernating females attain full growth, and commence ovipositing in the early part of May. The eggs are deposited beneath the mother scale, her body gradually shrinking, as the process of ovipositing goes on, until when ovipositing is finished, only the hard scale covering filled with eggs remains. The eggs begin hatchng about the first of June, and from that time on until the middle of August young crawling scale can be found upon an infested tree on every bright day. The young when hatched are very small, flat, quite active creatures, which soon find their way to the leaves, where they settle along the mid-rib and veins upon either surface. They remain on the leaves for six to eight weeks. The males then emerge winged, and the females, after being fertilized, go back to the twigs and small branches, along the undersides of which they attach themselves. As seen upon the leaves the young scales are considerably longer than broad, flat and semi-transparent, appearing as greenish-white spots. After their migration to the twigs, the females continue to feed and grow until cold weather, at which time they are about half grown. They then become dormant until Spring, when they complete their growth and deposit eggs, as already described.

PARASITES.

This scale insect is attacked by both insect and fungus parasites of great efficiency, and it is because of these that the scale has not become a worse pest than it has. The two most effective enemies seem to be a small Chalcid fly, and a fungus disease closely related to, if not identical with *Cordyceps clavulata*. The work of the Chalcid is apparent wherever the scale is found in this State. Examination of an infested tree rarely failed to show a large number of empty scale-shells, each with a tiny round hole in the back, showing where the parasite had come out. Some cases were observed in which it was estimated that forty to fifty per cent. of the scale had been parasitized.

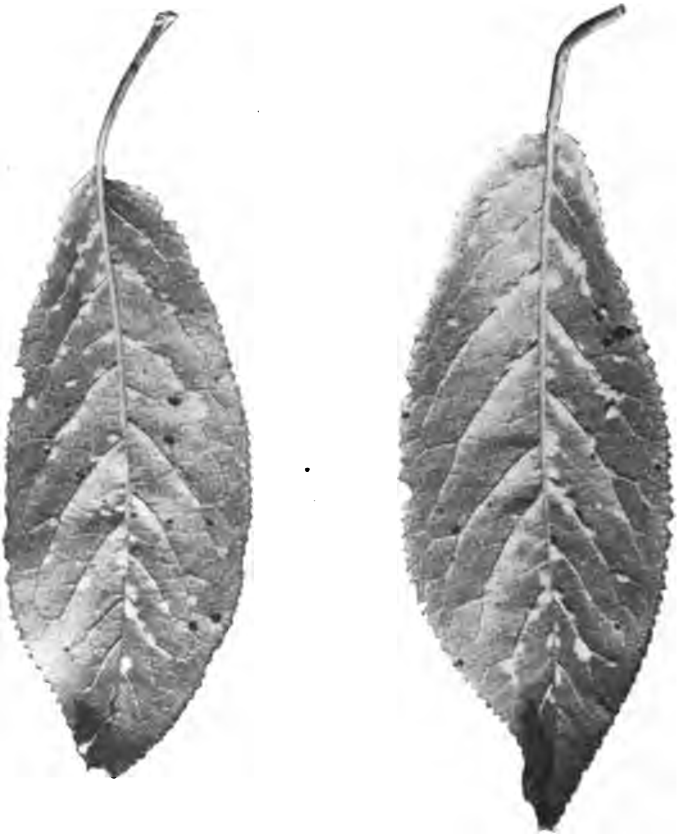

Figure 4.—Young Terrapin scales on the leaves and showing infestation with entomogenous fungus. (Original).

The fungus parasite was first observed attacking the scale on the plum trees before mentioned as occurring on the College farm. These trees were five in number, all badly infested, and were being closely watched for the purpose of taking notes on the life history of the scale. In the early part of July, 1906, a number of scales on one of the trees were observed encircled by a ring of whitish mould, and upon examination were found to be dead. Subsequent observations revealed the fact that the disease was spreading, and it was carefully watched. Within three weeks it had attacked practically every scale, both young and old, on the tree upon which it originally appeared, and was spreading to the other trees. By the middle of September some scale on each of the five infested trees were diseased, and when cold weather set in it was impossible to find a scale on any of them that was not diseased. A careful examination the following spring, of all the five formerly infested trees, as well as the trees contiguous to them in the orchard, failed to discover a single live specimen of scale upon any of them. All but a few scattering individuals had dropped off, leaving the bark of the trees clean, except for a ring of the mould where each scale had been. The accompanying cuts illustrate very clearly the appearance both of the young on the leaves and the adults on the twigs when attacked by this fungus.

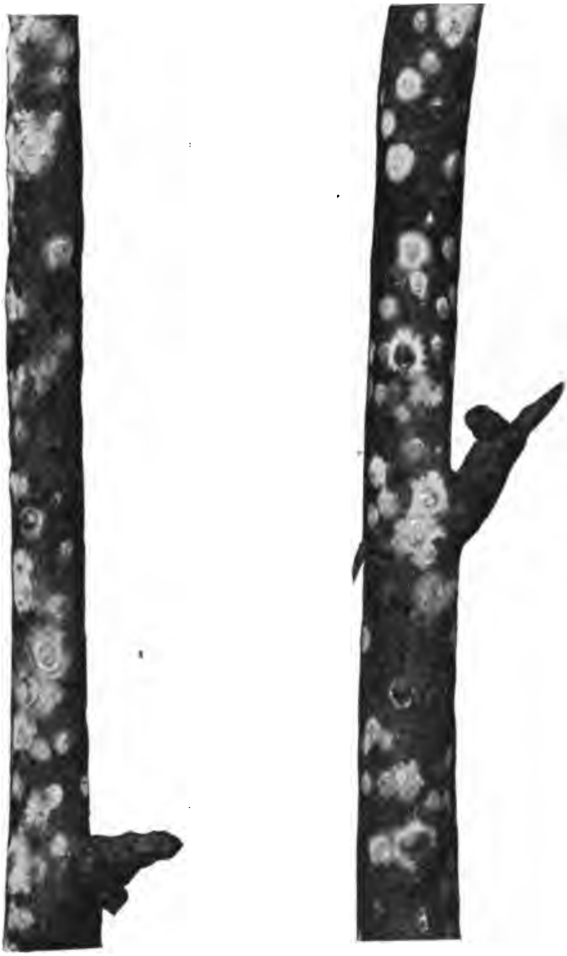

Figure 5.—Appearance on peach twigs, of adult Terrapin scales attacked by entomogenous fungus. (Original).

The value of such an entomogenous fungus can hardly be estimated, and peach growers would do well to be on the watch for it, and give it protection where found. The writer is unable to say whether spraying with insecticides for the scale will destroy the fungus, but would advise allowing trees whereon the disease makes its appearance to go unsprayed, rather than run the risk of destroying so beneficial a parasite.

EXPERIMENTS.

It was possible to find record of but little work that had ever been done with insecticides for the control of the Terrapin scale. Practically all writers who have undertaken to prescribe a remedy at all heretofore, have recommended the use of ten per cent. kerosene emulsion applied as a summer spray, or twenty per cent. used during the dormant season. The lime sulfur wash has been almost universally branded as a failure as a remedy for it. In view of the fact that the pest has become one of considerable economic importance in the State, and as there seemed to be very little definite information concerning insecticides to be used against it, a series of experiments, to determine, if possible, the most satisfactory means of combatting it, was undertaken. Accordingly, two badly infested peach orchards, comprising about five hundred trees, were selected and treated as follows:

One hundred and seventy-five trees were sprayed March 22, with miscible oil, using one part oil to 22.5 parts water.

Eighty trees sprayed March 22, with miscible oil, using one part oil to fifteen parts water.

Twenty-five trees sprayed April 7, with miscible oil, using one part oil to ten parts water.

Two hundred trees sprayed March 22, with lime sulfur wash, using twenty pounds lime to fifteen pounds sulfur.

Fifteen trees sprayed April 7, with lime sulfur wash, using 20 pounds lime to fifteen pounds sulfur.

Eight trees sprayed August 2, with ten per cent. kerosene emulsion.

Three different proprietary brands of the soluble oils were used (Kiloscale, Scalecide and Soluble Petroleum). As all are much alike, and as the results for each, where the same strengths were used, were practically the same, it is sufficient for the purposes of this bulletin that they be treated as one. Besides being applicable during the dormant season, these oils possess the additional advantage of being easily prepared, and not disagreeable to apply. Results being equal, most growers will prefer to use them rather than the lime sulfur wash or kerosene emulsion.

The lime sulfur wash employed in these experiments was made according to the formula now generally recommended for the San Jose Scale, viz.: Twenty pounds of lime, fifteen pounds of sulfur, and fifty gallons of water. The lime and sulfur cooked in twenty gallons of water for three-quarters of an hour, and then diluted with cold water to fifty gallons, and applied while warm.

The kerosene emulsion was made according to the usual method, and applied the first week in August, after the most of the scale had hatched and settled upon the leaves. The object in this experiment was to test the effect of one spraying in midsummer, as compared to one treatment during the dormant season with the lime sulfur and miscible oil washes. The application was delayed until most of the eggs had hatched, as it was thought that the treatment would then be more effective. This is now believed to have been a mistake, however, as the majority of the eggs had hatched three or four weeks before the spray was applied, and the young were upon the leaves, where many of them were undoubtedly missed by the spray. Had the treatment been given about the first of July it would doubtless have been more successful, since the young scale would then have been more easily reached with the spray, as but few had yet gone to the leaves.

The lime sulfur wash and the miscible oil were applied at the time of year which has proven most satisfactory for the treatment of the San Jose Scale, viz., shortly before the leaves come out in the Spring. The advantages of being able to spray during the dormant season are so patent, and have been so often pointed out, that there is no need to mention them here. Suffice it to say that other things being equal, a spray that can be applied effectively at that time is much to be preferred to one that has to be used in the summer.

The sprayed plats were examined during the summer months, to note their condition, but final notes were not taken until September 21, when the surviving young had all left the leaves, and were settled upon the twigs preparatory to hibernation.

RESULTS.

The results obtained from these experiments were in some cases not as expected, but they are believed to be reasonably accurate. The kerosene emulsion apparently accomplished the least good. The sprayed trees were somewhat less infested than were check trees left untreated, but the improvement was not sufficient to pay for the trouble which the treatment necessitated. As has been already pointed out, the failure of this wash may have been due in part to the lateness of the application, but even had it been applied earlier the probabilities are that the results would not have been equal to those from the Spring applications of the lime sulfur and miscible oils, on account of the difficulty of doing perfect work when the leaves are on the trees. Because of the long-hatching period of the eggs of the insect, it is highly improbable that one midsummer application of kerosene emulsion can be made to rid a tree of this scale.

Contrary to expectations, the trees sprayed with the lime sulfur wash showed great improvement at the time of the final examination. While not entirely free from scale, the numbers of the pest had been so reduced as to leave the trees in good condition. What scale remained were confined to the tips of the branches upon the wood which had grown since the wash was applied. The examinations of the trees during July and August had shown that the wash had had but slight effect upon the adult females, most of which succeeded in reaching maturity and depositing eggs. In July a great many young scales were observed, not only crawling on the trunk and limbs, but upon the leaves as well. These had disappeared, however, at the time of the final examination, indicating that in the case of this scale, as with the San Jose Scale, the chief benefit derived from the lime sulfur wash is that its presence on the trees during the breeding season prevents the young scale from settling, rather than that the over-wintering females are killed by it.

The most gratifying results, however, were obtained in the use of the miscible oils. In the weaker dilution (one part oil to 22.5 parts water) these preparations gave results about equal to the lime sulfur wash; but on the trees upon which one part of oil to fifteen parts water, and where one part oil to ten parts water, were used the number of scale remaining in September was exceedingly small. Some of the trees were entirely freed of the pest, and all were in good shape. No appreciable difference was apparent between the 1-10 and the 1-15 plats.

In the case of these oils the effect upon the scale is immediate, instead of being delayed, as with the lime sulfur wash, the over--wintering females being killed by the application. It was noticeable that the scales became loosened upon the twigs shortly after the oil was applied, and many of them dropped off before the breeding season began.

CONCLUSIONS.

These experiments, although extending over but one season's work, are sufficiently convincing, it is believed, to warrant the following conclusions being drawn:

1. That one application during the growing season, of kerosene emulsion, while better than no treatment, cannot be relied upon to suppress the terrapin scale in a badly infested orchard.
2. That the lime sulfur wash applied in the springtime, just before the leaves start, is a fairly efficient remedy.
3. That the proprietary preparations, or miscible oils (Kiloscale, Scalecide and Soluble Petroleum), applied in the proportions of one part oil to fifteen parts water, or stronger, constitute a satisfactory remedy for this pest.

The thanks of the Department, and of the writer, are due and are hereby extended to Mr. A. L. Towson, Smithsburg, Md., and Mr. Samuel King, Mapleville, Md., for their co-operation in the carrying out of the experiments by the loan of their respective orchards for the purpose, and the furnishing of men and apparatus for doing the work.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 124. DECEMBER, 1907.

STRAWBERRIES.

BY C. P. CLOSE, W. R. BALLARD AND T. H. WHITE.

INTRODUCTION.

Inasmuch as this Station has published nothing on strawberries since bulletin No. 33 appeared, in 1895, we are justified in including in this bulletin minute descriptions of many old varieties which have been grown for several years in the testing beds. The descriptions were all made from fruits of the 1907 crop. The yields are given in tabular form for the years 1905, 1906 and 1907. Each variety was allowed 70 square feet of row space, and the yield per acre is computed from the actual yield of this amount of land.

Usually the beds are fruited only one year, but the 1905 beds were kept for a second crop. When the young plants for new beds are taken from the Station plantation they are set out in early spring and are well cared for during the season. It often happens that plants sent here for testing arrive late in the spring and before they get well established are injured by drought and never recover sufficiently to give a full yield of fruit. Such was the case in 1906 with some varieties which produced very small yields in 1907. In early winter the plants are mulched with straw or coarse stable manure to protect them from the heaving effect of frost.

The soil at the Station is not well adapted to the testing of strawberries; it is a rather heavy, cold, clay loam, very uneven in texture and quality. This unevenness in quality no doubt accounts for some of the great differences in yield of varieties side by side.

CLIMATIC CONDITIONS.

The early part of the season of 1905 was marked by a drought which was very severe on young beds just set, but not so injurious to the fruiting beds. These young beds were not only somewhat weakened in 1905, but in May, 1906, when they were in bloom a very heavy freeze killed most of the blossoms and reduced the crop to almost nothing.

The terminal fruit buds on the fruiting beds for 1907 were killed by the severely cold weather of February when the thermometer registered 15 degrees below zero. The season of 1907 was cold, damp and cloudy, so that the berries did not ripen as early as usual, but continued ripening over a longer season than customary. Under such climatic conditions the fruit could not develop its highest quality, and this must be taken into consideration in reading the descriptions which follow, because in an ordinary season the quality would undoubtedly be much better than it was in 1907.

RECOMMENDING VARIETIES.

The strawberry is so peculiar in its adaptability to soil and climatic environment that it is not wise to recommend varieties except with restrictions. A variety will succeed admirably in one locality and fail dismally a few miles distant. It is well to plant principally the varieties which do well in the neighborhood and test new varieties which seem to be promising. The Gandy appears to be an exception as it usually does well on most low, moist, black, sandy loams. The Station soil is so different from that of the strawberry sections of the State that the behavior of a variety here is no criterion of what it will do elsewhere. Considering this cool and damp season only, such varieties as Yant, New York, Armstrong and Dole might safely be mentioned as most promising, yet when they were tested here a few years ago they were discarded as unsatisfactory. The Togo Seedling No. 2, which produced 12,498 quarts per acre in 1905, has done very poorly since. The best practice is to watch varieties in one's neighborhood and grow principally those which succeed best. It is also desirable to try promising new varieties in a small way, and thus determine which ones are likely to be adapted to any section.

SELECTING, PREPARING AND IMPROVING THE SOIL.

A sandy loam is best for the strawberry, but heavier loams may be used if necessary. Freshly plowed sod should be avoided because of the various insects especially cut worms, white grubs and wire worms, which it contains. It is well, also, to avoid corn and melon fields which have been infested with aphids, because the ants which associate with corn and melon aphids will also associate with strawberry aphids. Thus it is that if the ground is already infested with ants when strawberries are planted the strawberry aphis will spread quickly if it is introduced in any way. Sweet potatoes, round potatoes and tomatoes are good crops to precede strawberries because they require thorough cultivation.

If tomatoes are being grown, crimson clover seed, 20 pounds per acre, should be sown at the last cultivation, so as to have a good cover crop to plow under in the spring. Irish potatoes should be immediately followed by crimson clover seed. It may be too late to sow crimson clover seed after sweet potatoes are dug, and in that case rye, one bushel per acre, should be used. The object is to get as much green vegetable matter as possible to plow under.

If it is desired to improve very poor land for strawberry growing sow cowpeas, one bushel per acre, in May, plow them under early in August and sow crimson clover seed, 20 pounds per acre; plow this under in the spring and set the strawberries. If some special crop occupies the ground during the summer sow the crimson clover seed as early in August as possible, plow down the crop in May following, sow cowpeas, turn these under perhaps in September and sow rye, plow this down in spring and set the strawberry plants. If stable manure can be procured it may be used most liberally even up to 40 tons per acre before planting tomatoes, round or sweet potatoes, and after these crops more manure or cover crops may be used before strawberries are planted. By following either of these plans large amounts of humus will be added to the soil and humus is just what strawberries delight in and need. New ground is best for strawberries because it is full of humus, but since new ground is not always available it becomes necessary to make old ground resemble it in physical condition and fertility. The soil should be thoroughly worked into a loose and friable condition for receiving the plants in spring.

FERTILIZERS.

The question of fertilizers for strawberries can be discussed only in a general way because so many factors enter in, such as different grades of soil, different degrees of fertility of the soil, different previous treatment and.crops, and different seasonal conditions and handling of the fruiting bed.

The 3-9-7 formula (3 per cent. nitrogen, 9 per cent. potash and 7 per cent. phosphoric acid) seems to be a popular one for strawberries, and the amounts of fertilizer in the first formula below are suggested per acre as furnishing enough plant food to comply with the 3-9-7 formula. If the grower wishes to use more than these amounts it might be well to increase all in the same proportion:

Per acre	100 lbs. nitrate of soda, or 75 lbs. sulphate of ammonia, or 250 lbs. cottonseed meal. 90 lbs. sulphate of potash, or 95 lbs. muriate of potash, or 400 lbs. kainit. 250 lbs.. acid phosphate, or 250 lbs. dissolved bone.

A little variation from the above is:

500 to 1000 lbs. Per acre	500 to 700 lbs. ground fish, bone meal or tankage. 200 lbs. muriate of potash. 1,100 to 1,300 lbs. acid phosphate.

Other amounts sometimes used are:

Per acre new beds
200 lbs. muriate of potash.
600 lbs. dissolved S. C. Rock.

Per acre old beds
100 lbs. nitrate of soda.
200 lbs. muriate of potash.
200 lbs. dissolved S. C. Rock.

For new beds the fertilizer should be applied in spring, before the plants are set, either broadcast by wheat drill, or otherwise, or along the rows. In either case, but especially in the latter, the fertilizer must be thoroughly mixed into the soil with the cultivator or it may injure or destroy many of the plants.

If beds are to be kept for second year fruiting the fertilizer should be applied along the rows when they are cleaned up after the first crop is picked.

Nitrate of soda is sometimes used on fruiting beds about blossoming time, being applied along the rows at the rate of 75 to 100 pounds per acre.

SEX IN STRAWBERRIES.

The fact that some varieties have imperfect, pistillate or female blossoms, and others have perfect blossoms which are called staminate, bi-sexual, or male blossoms, and that varieties with imperfect blossoms should be planted next to those with perfect blossoms in order to obtain proper pollination of all blossoms and a good setting of fruit, is well-understood. From two to four rows of any imperfect flowered variety should be alternated with from one to four or more rows of a perfect flowered variety blooming at the same time. It is even claimed that perfect flowered varieties will fruit better if planted in alternate sets of rows so as to secure cross pollinaton.

SETTING THE PLANTS.

Set the plants as early in the spring as possible. In Southern Maryland the ground is sometimes prepared in late fall and the planting is done in winter whenever the weather permits. The plants are trimmed for setting by taking off all dead leaves and all except one or two of the live ones, and cutting the roots back to about three inches in length. This root pruning is quickest done with pruning shears or knife removing all of the surplus roots from a bundle of 25 plants at one or two cuts. Keep the plants moist; a bucket containing a little water is handy for this purpose while planting. A spade or broad-bladed dibble is convenient for opening up the soil to receive the plants. The particular point is to place the plants so the crown is just above ground and to press the soil firmly around the roots. The opening made to receive the plant must be entirely closed.

The matted row system is best adapted for commercial purposes. The rows are usually made three and one-half or four feet apart and the plants are set from 15 to 18 inches apart in the row. The width of the matted row depends upon the wishes of the grower, he may have it either wide or narrow. If blossoms appear they should be removed so the plants will put all of their energy into growth.

CULTIVATION.

The ground must be thoroughly cultivated during the entire growing season to keep it loose and friable. This condition of the soil is beneficial in several ways. It allows the air to penetrate the soil which is necessary as roots need air; it retains moisture in the soil by preventing rapid evaporation from the surface; it assists in breaking down plant food which would otherwise remain insoluble and it keeps the ground free from weeds which rob the plants of moisture.

It is not a usual practice to cultivate the fruiting beds in spring, but this ought to be done to loosen up the soil so it will hold more moisture and evaporate less, and thus in case of drought the crop will not suffer so quickly if at all.

MULCHING.

As soon as the ground freezes the plants should be covered with straw, coarse manure, pine needles, sea weed, or something else to prevent frost from heaving out the plants. If the new growth in spring cannot easily work its way up through the mulch it is necessary to remove enough of it so as not to injure the plants. The mulch must be left beneath the plants so as to keep the berries from touching the earth and also to prevent the rain from spattering them with sand and dirt. In fact, even if the winter is not severe enough to require mulching for protection, it should be done anyway to protect the berries from dirt and sand for gritty fruit is a drug on the market.

PICKING AND PACKING THE FRUIT.

Too much emphasis cannot be laid on the care necessary in picking and packing strawberries. The fruit stem should be pinched off carefully without bruising or even pressing on the berry with the hand. Only good fruit should be picked for shipment. The baskets should be well filled so as not to appear slack when they are offered for sale in the market. The 24 and 32 quart crates are by far the best to use as these sizes handle better, carry better, and sell better than larger crates. Above all things use only clean, new crates and baskets, because soiled ones are almost a disgrace to modern berry growing. Aside from the aesthetic feature and the satisfaction of putting good fruit in clean packages, it pays financially to invest in bright new baskets and carriers.

RENEWING OLD BEDS.

As soon as the fruit is gathered it is well to mow the patch and burn it over quickly as soon as dry enough, so as to destroy as much of foul matter, fungous diseases and insects as possible. Then plow between the rows throwing furrows together and cut the rows to about one foot in width. Thin out the remaining plants leaving only the young, vigorous ones, and cultivate the ground level between the rows. Another way is to plow down one-half of the width of each row, cultivate well and let new runners cover it from the remaining half. When enough new plants are established the old portion of the row should be plowed down and cultivated and practically a new plantation will be secured. Cultivation should be continued until the end of the growing season. Ordinarily the strawberry field is plowed up and planted to some other crop after the second year, principally because of the expense of cleaning up an old bed.

If it is desired to grow one's own plants this may be done by planting a few rows extra for this special purpose. The practice is a good one.

MULCHING EXPERIMENTS FROM 1902 TO 1906.

The following table shows at a glance the plan of the tests and the results for each year. Plot 1 was covered with straw in early winter. Plot 2 was mulched with strawy horse manure, 10 tons per acre, at the same time. Plot 3 received commercial fertilizer to equal in amount the plant food in the horse manure on plot 2, but had no protecting mulch applied. The fertilizer was applied when the other plots were mulched. Plot 4 was a check, receiving no mulch.

Table Showing Treatment of Plots and Yields of Fruit Per Acre in 1902, 1903, 1904, 1905 and 1906.

Plots.	1902 qts. per acre	1903 qts. per acre	1904 qts. per acre	1905 qts. per acre	1906 qts. per acre
1. Straw mulch*	3744	3600	2505	1631	1166
2. Strawy horse manure mulch	3020	3066	2287	2310	1324
3. Com'l fertilizer but no mulch	1416	2385	762	1709	....
4. Check	2476	2925	1570	1709	1438

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*In 1904 small corn stalks from sowed corn were used instead of straw.

In 1902 the straw mulch plot produced 1,268 quarts per acre more than the check plot, and the strawy manure plot 544 quarts more than the check. These are substantial gains for the mulching work. The commercial fertilizer plot was a surprise in that its yield was 1,060 quarts less per acre than the check plot. Lovett, Glen Mary and Tennessee were the varieties used.

The 1903 results do not show so much gain for the mulching over the check plot, yet the gain for straw mulch was 675 quarts. The commercial fertilizer plot yielded 540 quarts per acre less than the check plot. Glen Mary and Gandy were used this year.

In 1904 the effect of mulching is much better than in 1903. The corn stalk mulch gain is 935 quarts, and the strawy manure mulch gain is 717 quarts over the check, while the loss for the commercial fertilizer plot is 808 quarts per acre.

During the season of 1904 the new bed for 1905 fruiting did not make satisfactory growth, so the 1904 fruiting bed was continued for fruiting in 1905. The results are rather unusual, inasmuch as the straw mulch plot yielded 78 quarts per acre less than the check plot. The strawy manure plot did very well in giving a gain of 601 quarts per acre over the check plot. The commercial fertilizer plot and the check plot yielded equal amounts. Because the commercial fertilizer seemed to cause a reduced yield during three years and did not increase the yield the fourth year compared with the check plot, it was not continued in the 1906 work.

The 1906 crop was badly injured by a drought during blossoming time and a heavy freeze in May, and the yields are unfavorable for the mulched plots. The check plot yielded 272 quarts per acre more than the straw mulch plot and 114 quarts per acre more than the strawy manure mulch. In 1904, 1905 and 1906 the Lovett only was used in this test.

Considering the five seasons the gain in yield of the straw mulch over the check is 2,528 quarts, and the gain for strawy manure mulch over the check is 1,889 quarts. During the four seasons in which the commercial fertilizer was continued the total loss in yield for it was 2,408 quarts compared with the check plot. From these results the straw mulch applied in early winter is most earnestly recommended.

MULCHING EXPERIMENTS IN 1907.

The question of a crabgrass mulch was being discussed and the plan of the experiment was changed to include a crabgrass plot for fruiting in 1907. The Tennessee was the variety used. There were five plots each 20 by 100 feet in size handled as follows:

Plot 1—received no cultivation after August 1, 1906, and the crabgrass was allowed to grow to form a mulch for the plants.

Plot 2—was cultivated until late in the Fall and was mulched with strawy fresh horse manure in early winter.

Plot 3—was handled like plot 2 except that wheat straw was used for a mulch.

Plot 4—was cultivated in the Fall like plots 2 and 3, but the wheat straw mulch was not put on until the Spring of 1907. This mulch was put on to hold moisture in the ground and to protect the fruit from dirt and grit.

Plot 5—check, was cultivated in the Fall like plots 2 and 3, but received no other treatment.

The dates of picking the fruit and the yields in quarts per acre from the five plots follow:

Plot	First Picking	Last Picking	Yield in Quarts Per Acre
1	May 31	June 18	2581
2	June 7	June 24	4946
3	June 7	June 24	6294
4	June 7	June 22	4100
5	June 7	June 22	3289

From these figures it is seen that plot 1, the crabgrass plot, produced ripe fruit a week earlier than any of the other plots, but its yield is 708 quarts less per acre than the check plot and 3,713 quarts per acre less than plot 3 mulched with wheat straw. At ten cents per quart this represents a gain for plot 3 of $371.30 per acre for Fall cultivating and mulching with straw. Plot 2 mulched with strawy manure yielded 1,657 quarts per acre more than the check plot. Plot 3 mulched with straw made a gain of 3,005 quarts per acre over the check and plot 4 which was not mulched until Spring made a gain of 811 quarts over the check. At ten cents per quart plot 3 produced $300.50 more per acre than the check plot and this represents the returns from a small investment in straw mulching.

Comparing the yields of plots 2, 3, 4 and 5 with the crabgrass plot, No. 1, the differences are even more striking. Plot 2 gained 2,365 quarts per acre, plot 3 gained 3,713 quarts, plot 4 gained 1,519 quarts, and plot 5 gained 708 quarts per acre over plot 1. These results indicate that it is most profitable to follow the practice of late cultivation and mulching.

YIELD OF VARIETIES IN TESTING PLOTS.

The following tables give the yield in quarts per acre of the varieties tested at the Experiment Station during 1905, 1906 and 1907. The 1905 bed was held over for second-year fruiting in 1906 and the yields are given in the 1906 column designated "old bed." The varieties are arranged alphabetically according to season of ripening as "early," "mid-season" and "late." The sex of each variety is designated by "S" for staminate or perfect flowers, and "P" for pistillate or imperfect flowers. No further explanation can be given for unevenness of yields than what is mentioned under "climatic conditions."

STRAWBERRY YIELDS IN QUARTS PER ACRE.

Variety Early	Sex	1905 qts.	Old Bed 1906 qts.	New Bed 1906 qts.	1907 qts.
Abington	S	....	....	....	3113
August Luther	S	....	....	....	591
Bountiful	S	....	....	....	4045
British Queen	S	816	50	....	2022

Variety			Old Bed	New Bed	
Early	Sex	1905 qts.	1906 qts.	1906 qts.	1907 qts.
Cameron	S	3848	2030	816	311
Catherine	P	....	....	....	1991
Climax	S	3168	1182	624	6658
Early Beauty	S	4974	1677	1446	1804
Early Hathaway	S	4232	3366	1134	3236
Elba	S	3440	1014	807	4636
Eleanor	S	....	....	....	498
Excelsior	S	3186	1446	2028	653
Fairfield	S	3972	594	....	1609
Gen. Joe Wheeler	S	....	....	....	4045
Glen Mary	S	4739	2004	1716	6036
Hall No. 2	S	....	...	....	1120
Haverland	P	3576	4488	2616	1929
Heflin Early	P	....	....	....	1836
Hero	S	5407	567	216	1587
Hoffman	S	....	....	....	840
Johnson	S	1002	198	456	591
Kuropatkin	S	7969	3712	2244	4387
Lady Thompson	S	3316	1188	1224	6098
Louis Hubach	P	6534	5643	1464	1338
Mammoth	P	4528	1089	480	1587
May King	S	....	....	....	2551
Michel	S	2376	1240	456	1338
Oak Early	S	....	....	....	2147
Oom Paul	S	2796	312	408	1338
Reliance	S	....	....	....	715
Rio	S	....	....	....	1213
Senator Dunlap	S	....	....	....	1431
Springdale	S	1856	297	528	1609
Stakeley	P	5568	1782	600	3350
Superior	S	....	....	....	3298
Surprise	S	8922	2883	552	6411
Thompson Early	S	3564	1038	....	....
Thompson Earliest	S	3923	2673	792	1369
Thompson 203	S	3267	72	....	622
Thompson 501	S	3625	1732	1440	1462
Thompson 502	S	4343	2004	....	2458
Wild Wonder	S	....	....	....	1307
Yalu	S	2462	594	1104	1431
Mid-season.					
Advance	S	....	....	....	1189
Armstrong	S	....	....	....	3267
Arnout	S	....	....	....	3298
Auto	S	4182	748	216	2053
Beaver	S	....	....	312	1182

Variety Mid-season	Sex	1905 qts.	Old Bed 1906 qts.	New Bed 1906 qts.	1907 qts.
Ben Davis	S	5222	....	96	1376
Brunette	S	....	....	....	311
Bubach	P	4405	2268	696	902
Cardinal	P	....	....	....	3765
Challenge	S	....	....	....	3173
Chellie	S	2660	336	96	342
Cobden Queen	P	....	....	....	5943
E. H. Ekey	S	....	....	....	840
Gandy x Clyde No 1	S	....	....	336	809
Ham	S	....	....	....	1338
Howard	S	....	....	....	3796
Hummer	S	....	....	....	4324
Kansas	P	5247	2844	312	5911
King Philip	S	....	....	....	964
Lovett	S	6336	1584	396	1960
Lyon	P	10840	4248	1512	8992
Marie	P	7932	5022	552	3702
Marsden Perry	S	....	....	....	1836
McKinley	S	....	....	....	1431
New York	S	....	....	....	1396
North Shore	S	....	....	168	280
No. 1—02	S	....	....	408	3049
Parsons	S	6756	2178	1320	4543
Ridgeway	S	....	....	....	1244
Sample	P	4306	3218	1008	5663
Seaford	P	7932	3712	....	3733
Somerset Maid	S	....	....	....	1053
Stella	P	5464	1980	216	1929
Success	S	....	....	....	311
Sutherland	P	4021	3620	588	2613
Tennessee	S	2400	1254	1904	5538
Togo Seedling No. 1	S	3186	48	188	342
Togo Seedling No. 2	S	12498	1422	456	1751
Togo Seedling No. 3	S	3316	490	336	693
Togo Seedling No. 4	S	4836	1238	501	373
Wolverton	S	....	....	....	3732
Yant	S	....	....	72	3920
Late.					
Arizona Everbearing	S	....	....	....	1804
Aroma	S	....	....	....	840
Bismark	S	1881	567	....	2178
Boston Prize	P	....	....	....	1058
Bowman 1 S	S	2984	99	24	1120
Bowman 24 D	P	5593	742	96	2520
Brandywine	S	4233	1358	72	4854

Variety Late	Sex	1905 qts.	Old Bed 1906 qts.	New Bed 1906 qts.	1907 qts.
Buster	P	....	....	....	7280
Commonwealth	S	2846	408	96	1991
Crimson Cluster	S	....	....	....	715
Dayton	S	....	....	....	373
Dixie Belle	P	....	....	....	1735
Dole	P	3564	1089	1224	5009
Enormous	P	3217	1917	456	1804
Gandy	S	1608	1510	336	1866
Isabella	S	1757	831	240	5663
Jessie	S	4504	312	192	1680
Joe	S	3811	740	96	1773
Kittie Rice	P	2982	1326	728	1617
Klondyke	S	3094	168	....	2738
Latest	P	2524	2475	1368	3350
Leaver	S	606	72	120	809
Lester Lovett	S	3910	1683	504	3298
Major Stoessel	S	321	....	....	311
Mark Hanna	P	3564	2722	48	964
Meade	S	....	....	....	2488
Midnight	S	2190	1230	240	3329
Minute Man	P	3811	2030	696	3982
Mrs. M. Hanna	S	1782	545	....	2240
Nettie	P	....	....	....	1866
New Globe	S	....	....	....	3609
New Home	S	....	....	96	1369
Nick Ohmer	S	4158	50	96	1369
Ninety-Six	S	4950	336	48	2022
Olives Pride	S	1881	96	120	622
Pocomoke	S	5556	1653	456	5663
Porto Rico	P	730	....	....	1244
Pride of Cumberland	S	1707	594	600	4169
Salem	S	6410	247	240	4418
Stevens Late Champion	S	....	....	....	1804
Tilghman Favorite	P	....	....	528	4511
Tubbs	S	1670	302	336	2302
Uncle Jim	S	4578	72	144	3609

Ten Best Yielding Varieties.

Quarts per acre in 1905, 1906 and 1907.

Variety.	Sex.	1905 Qts.	Variety.	Sex.	1906 Qts.	Variety.	Sex.	1907 Qts.
Togo Seedling No. 2	S	12,498	Louis Hubach	P	5,643	Lyon	P	8,992
Lyon	P	10,840	Marie	P	5,022	Buster	P	7,280
Surprise	S	8,922	Haverland	P	4,488	Climax	S	6,658
Kuropatkin	S	7,969	Lyon	P	4,248	Surprise	S	6,411
Marie	P	7,932	Kuropatkin	S	3,712	Lady Thompson	S	6,098
Seaford	P	7,932	Seaford	P	3,712	Glen Mary	S	6,036
Parsons	S	6,756	Sutherland	P	3,620	Cobden Queen	P	5,943
Louis Hubach	P	6,534	Ey. Hathaway	S	3,366	Kansas	P	5,911
Salem	S	6,410	Sample	P	3,218	Isabella	S	5,663
Lovett	S	6,336	Surprise	S	2,883	Pocomoke	S	5,663
						Sample	P	5,663

Of the ten best yielding varieties Lyon has the best average for three years, but the berries are so small that it is not desirable. The same is true of Kuropatkin and Louis Hubach although one point in favor of these is that they are early in ripening. Climax did well in 1907 only. Buster is very promising, but has had only one year's trial. Togo Seedling No. 2 has yielded poor crops since 1905.

VARIETIES.

The descriptions of varieties are arranged alphabetically so that any one may be easily found. The "S" following the name of a variety means that the variety has "staminate" or "perfect" flowers, and "P" means that it has "pistillate" or "imperfect" flowers. The name enclosed in parenthesis indicates the source of the plants of any variety; thus (W. F. Allen) means that Mr. Allen furnished the plants and (Station Plot) means that the plants were taken from test plots at the Experiment Station the previous year. The three dates given under blooming mean the time of first bloom, full bloom and last bloom, respectively. The two dates under season are the days of first and last pickings of fruit.

ABINGTON, S.—(W. F. Allen). In bloom May 1-10-20; fair stand; plants moderately large and vigorous; leaflets large, dark; little disease; runners not plentiful; flowers perfect; trusses large, moderately erect, many flowered; berry not uniform, slightly ridged, round-conic, rough wedge shaped, blunt, medium to above, dull crimson, slightly pitted; flesh light pink, firm, moderately juicy, mild sub-acid,-fair; core white, solid; calyx large, separates easily; seeds many, small. Season, June 4-24; yield 3,113 quarts per acre.

Advance, S.—(W. F. Allen). In bloom April 29-June 6-18; fair stand; plants small, not vigorous; leaflets small, light green; very little disease; runners many; flowers perfect, medium to large; trusses short, not erect, many flowered; berry uniform, slightly necked, long conic to oblong, somewhat flattened at tip, medium size, bright scarlet, slightly pitted; flesh light red, firm, juicy, mild sub-acid, flat, fair; core pink, not solid; calyx medium, separates easily; seeds many, large. Season, June 4-24; yield 1,189 quarts per acre.

Arizona Everbearing, S.—(W. F. Allen). In bloom, May 3-11-18; thin stand; plants small, not vigorous; leaflets medium, dark; little disease; runners few; flowers perfect, medium size; trusses short, bending, many flowered; berry uniform, round-cordate, large, bright scarlet, slightly pitted; flesh light pink, not firm, juicy, mild sub-acid, fair; core pink, solid; calyx large, adherent, diseased; seeds many, large. Season, June 15-24; yield 1,804 quarts per acre.

Armstrong, S.—(W. F. Allen). In bloom April 26-May 8-20; fair stand; plants large, vigorous; leaflets medium, dark; very little disease; runners few; flowers perfect, large; trusses short, erect, many flowered; berry not uniform, round-conic to wedge-shaped, coxcombed, large, bright scarlet to crimson, very slightly pitted; flesh light pink, firm, not juicy, sweet, good; core pink, solid; calyx large, adherent; seeds many, large. Season, June 15-24; yield 3,267 quarts per acre.

Arnouts, S.—(W. F. Allen). In bloom May 2-13-20; fair stand; plants medium, moderately vigorous; leaflets medium, dark; little disease; runners not plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry not uniform, ridged, round-conic, flattened, often double and irregular, very large, bright and dark crimson, slightly pitted; flesh red, firm, juicy, sub-acid, fair; core red, solid; calyx large, persistent; seeds many, large. Season, June 4-24; yield 3,298 quarts per acre.

Aroma, S.—(J. G. Harrison & Sons). In bloom May 1-10-20; thin stand; plants small, not vigorous; leaflets large, dark; very little disease; runners plentiful; flowers perfect, large; trusses moderately large, fairly erect, many flowered; berry uniform, conic, wedge-shaped, blunt, medium to large, bright scarlet, pitted; flesh light red, not firm, juicy, mild sub-acid, fair; core white, solid; calyx medium, adherent; seeds many, small. Season, June 4-24; yield 840 quarts per acre. A good variety for home use.

August Luther, S.—(W. F. Allen). In bloom May 1-6-16; thin stand; plants very small, not vigorous; leaflets small, dark; very little disease; runners very few; flowers perfect; trusses short, not erect, many flowered; berry uniform, slightly ridged, conic, medium size, dull crimson, slightly pitted; flesh light red, firm, juicy, sub-acid to acid, fair; core white, solid; calyx medium, persistent; seeds many, large. Season, June 4-17; yield 591 quarts per acre.

AUTO, S.—(Station plot). In bloom April 26-May 6-18; fair stand; plants large, vigorous; leaflets medium, dark; little disease; runners not plentiful; flowers perfect, medium to large; trusses short, not erect, many flowered; berry not uniform, somewhat necked, slightly ridged, conic, roundish, irregular, flattened, coxcombed, medium to large, crimson, slightly pitted; flesh light red, firm, juicy, mild sub-acid, sweet, good; core pink, solid; calyx large, separates easily; seeds very many, large. Season, June 4-20; yield 2,053 quarts per acre.

BEAVER, S.—(Station plot). In bloom May 3-13-18; fair stand; plants moderately large, moderately vigorous; leaflets medium, dark; considerable disease; runners plentiful; flowers perfect, small; trusses small, not many flowered; berry not uniform, slightly necked, round-conic, blunt, medium size, light crimson, slightly pitted; flesh light red, moderately firm, juicy, sub-acid, fair; core solid, light pink; calyx medium, separates easily; seeds many, large. Season, June 7-24; yield 1,182 quarts per acre.

BEN DAVIS, S.—(Station plot). In bloom April 26-May 6-20; fair stand; plants small, not vigorous; leaflets small, light; little disease; runners plentiful; flowers perfect, medium to large; trusses short, not erect, many flowered; berry uniform, slightly ridged, round-conic, medium size, bright and dark crimson, slightly pitted; flesh light red, firm, juicy, mild sub-acid, sweet, good; core pink, not solid; calyx medium, adherent; seeds many, large. Season, June 4-24; yield 1,376 quarts per acre.

BISMARK, S.—(Station plot). In bloom May 6-15-24; rather poor stand; plants not large, not vigorous; leaflets medium, dark; considerable disease; runners not plentiful; flowers perfect, medium to large; trusses short, not erect, many flowered; berry not uniform, slightly ridged, roundish, wedge-shaped, uneven, cordate, medium to large, dark scarlet, slightly pitted; flesh rich red, not firm, moderately juicy; sub-acid, fair; core solid, pink; calyx medium, adherent; seeds many, large. Season, June 12-24; yield 2,178 quarts per acre.

BOSTON PRIZE, P.—(J. G. Harrison & Sons). In bloom May 1-11-18; fair stand; plants large, vigorous; leaflets medium, dark; very little disease; runners not plentiful; flowers imperfect, large; trusses medium large, not erect, many flowered; berry not uniform, slightly ridged, conic, wedge-shaped, medium to large, bright scarlet, pitted; flesh light red, firm, juicy, mild sub-acid, fair; core pink, solid; calyx medium, adherent; seeds many, small. Season, June 14-24; yield 1,058 quarts per acre.

BOUNTIFUL, S.—(J. E. Kuhns, Cliffwood, N. J.). In bloom May 1-10-18; fair stand; plants large, vigorous; leaflets moderately large, dark; very little disease; runners few; flowers perfect; trusses short, not erect, many flowered; berry not uniform, ridged, round, flattened tip, coxcombed, medium to very large, scarlet to light crimson, pitted; flesh light red, firm, not juicy, sub-acid to acid, fair; core pink, solid; calyx medium, persistent; seeds many, large. Season, June 4-24; yield 4,045 quarts per acre. Seedling of Glen Mary probably crossed with Clyde.

BOWMAN No. 1, S.—(Station plot). In bloom May 2-10-20; fair stand; plants large, vigorous; leaflets medium, dark; little disease; runners not plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry not uniform, slightly necked, somewhat ridged, roundish, irregular conic, medium to large, bright and dark crimson, slightly pitted; flesh red, not firm, juicy, mild sub-acid, sweet, fair; core red, solid; calyx medium, adherent; seeds many, large. Season, June 4-24; yield 1,120 quarts per acre.

BOWMAN 24 D, P.—(Station plot). In bloom May 6-18-22; rather poor stand; plants not large, vigorous; leaflets small, light; very little disease; runners not plentiful; flowers imperfect, medium; trusses short, not erect, many flowered; berry uniform, cordate-conic, large, bright scarlet, slightly pitted; flesh light red, not firm, juicy, mild sub-acid, good; core pink, solid; calyx large, separates easily; seeds many, large. Season, June 12-24; yield 2,520 quarts per acre.

BRANDYWINE, S.—(Station plot). In bloom May 1-14-20; good stand; plants small, not vigorous; leaflets medium large, light; very little disease; runners plentiful; flowers perfect; trusses medium large, erect, many flowered; berry uniform, slightly ridged, round-conic, flattened tip, large, bright dark scarlet, slightly pitted; flesh very bright red, firm, not juicy, sub-acid to acid, fair; core red, solid; calyx large, persistent; seeds many, large. Season, June 7-24; yield 4,854 quarts per acre.

BRITISH QUEEN, S.—(Station plot). In bloom May 2-13-20; good stand; plants large, moderately vigorous; leaflets small, dark; little disease; runners plentiful; flowers perfect; trusses not large nor erect; berry not uniform, moderately ridged, round-pointed to wedge-shaped, very large, bright crimson, slightly pitted; flesh deep pink, firm, juicy, sweet, good; core solid, pink; calyx large, separates easily; seeds many, medium. Season, June 4-20; yield 2,020 quarts per acre. This is a seedling of the British Queen grown in England.

BRUNETTE, S.—(W. F. Allen). In bloom April 24-May 6-16; poor stand; plants quite small, not vigorous; leaflets small, dark; little disease; runners very few; flowers perfect; trusses short, not erect, many flowered; berry uniform, slightly ridged, conic, medium size, very dark crimson, slightly pitted; flesh light red, firm, not juicy, sub-acid, fair; core white, not solid; calyx medium, persistent; seeds many, large. Season, June 7-17; yield 311 quarts per acre.

BUBACH, P.—(Station plot). In bloom May 4-13-20; very poor stand; plants small, not vigorous; leaflets medium, dark; very little disease; runners few; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, ridged, conic, irregular wedge-shaped, large, bright crimson, slightly pitted; flesh rich, light red, firm, juicy, sub-acid, fair; core pink, solid; calyx medium, adherent; seeds many, large. Season, June 4-20; yield 902 quarts per acre.

BUSTER, P.—(W. F. Allen). In bloom May 4-15-20; good stand; plants small, not vigorous; leaflets medium, dark; very little disease; runners plentiful; flowers imperfect, small to medium; trusses short, not erect, many flowered; berry uniform, round-conic, large, dark scarlet and bright crimson, slightly pitted; flesh reddish pink, not firm, juicy, mild sub-acid, flat; core pink, not solid; calyx medium; seeds many, large. Season, June 7-24; yield 7,280 quarts per acre. Probably good for home markets on account of attractive appearance.

CAMERON, S.—(Station plot). In bloom April 24-May 4-18; poor stand; plants small, not vigorous; leaflets small, light; considerable disease; runners few; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, slightly ridged, roundish-cordate, small, light and dark scarlet, very slightly pitted; flesh light pink, not firm, juicy, mild sub-acid, fair; core pink, solid; calyx small, separates easily, diseased; seeds many, large. Season, May 31-June 4; yield 311 quarts per acre. Not worth further testing.

CARDINAL, P.—(W. F. Allen). In bloom May 6-15-20; fair stand; plants medium large, moderately vigorous; leaflets medium, dark; very little disease; runners few; flowers imperfect, medium; trusses short, not erect, many flowered; berry uniform, round-conic, large, attractive dark crimson, slightly pitted; flesh red, firm, juicy, mild sub-acid, fair; core red, solid; calyx large, separates easily; seeds many, large. Season, June 17-24; yield 3,765 quarts per acre.

CATHERINE, P.—(W. F. Allen). In bloom April 26-May 8-18; thin stand; plants large, not vigorous; leaflets small, light; very little disease; runners not plentiful; flowers imperfect; trusses moderately large, erect, many flowered; berry not uniform, ridged, conic, blunt, flattened tip, medium size, bright scarlet, pitted; flesh pink, firm, not juicy, sub-acid to acid, fair; core red, solid; calyx medium to large, persistent; seeds many, large. Season, June 4-24; yield 1,991 quarts per acre.

CHALLENGE, S.—(W. F. Allen). In bloom May 1-10-20; fair stand; plants small, not vigorous; leaflets small, dark; considerable disease; runners plentiful; flowers perfect; trusses short, not erect, many flowered; berry not uniform, ridged, conic, wedge shaped, flattened tip, medium to large, bright scarlet, pitted; flesh bright red, firm, not juicy, mild sub-acid, good; core light pink, solid; calyx medium to large, persistent; seeds many, large. Season, June 7-24; yield 3,173 quarts per acre.

Chellie, S.—(Station plot). In bloom May 6-13-20; very poor stand; plants small, vigorous; leaflets small, dark; very little disease; runners few; flowers perfect, medium to large; trusses short, not erect, many flowered; berry not uniform, occasionally necked, round-conic, wedge-shaped, sometimes flattened, large, crimson, slightly pitted; flesh pink, not solid, juicy, mild sub-acid, fair; core pink, solid; calyx large, persistent, diseased; seeds many, large. Season, June 14-24; yield 342 quarts per acre.

Climax, S.—(Station plot). In bloom April 26-May 9-20; good stand; plants large, vigorous; leaflets small, dark; very little disease; runners not plentiful; flowers perfect; trusses large, fairly erect, many flowered; berry not uniform, ridged, round-conic, blunt, medium to large, bright crimson, rather deeply pitted; flesh bright red, firm, juicy, sub-acid to acid, fair; core pink, solid; calyx medium to large, persistent; seeds many, small. Season, May 31-June 24; yield 6,658 quarts per acre.

Cobden Queen, P.—(W. F. Allen). In bloom May 2-13-20; good stand; plants large, vigorous; leaflets medium, light; little disease; runners abundant; flowers imperfect, medium to large; trusses medium, moderately erect, many flowered; berry uniform, round-conic, wedge-shaped, medium to large, attractive bright scarlet, slightly pitted; flesh light red, not firm, juicy, mild sub-acid, fair; core pink, solid; calyx medium, separates easily; seeds many, large. Season, June 4-24; yield 5,943 quarts per acre. Probably good for home market; very productive.

Commonwealth, S.—(Station plot). In bloom May 2-14-22; fair stand; plants medium large, moderately vigorous; leaflets small, dark; little disease; runners plentiful; flowers perfect; trusses short, not erect, many flowered; berry not uniform, moderately ridged, irregular, roundish-conic to coxcomb, large, dark crimson, pitted; flesh red, firm, moderately juicy, sub-acid, flat, fair; core solid, light red; calyx large, does not separate easily; seeds many, large. Season, June 4-24; yield 1,991 quarts per acre.

Crimson Cluster, S.—(W. F. Allen). In bloom May 6-18-22; fair stand; plants large, vigorous; leaflets large, dark; little disease; runners plentiful; flowers perfect, moderately large; trusses short, not erect, many flowered; berry uniform, wedge-shaped, blunt, medium to large, bright scarlet to crimson, slightly pitted; flesh red, firm, juicy, sub-acid to acid, sweet, good; core pink, solid; calyx large, adherent, diseased; seeds many, large. Season, June 16-24; yield 715 quarts per acre.

DAYTON, S.—(J. G. Harrison & Sons). In bloom April 26-May 6-18; poor stand; plants small, not vigorous; leaflets small, dark; very little disease; runners plentiful; flowers perfect, large; trusses short, not erect, few flowered; berry nearly uniform, sometimes slightly necked, long conic, flattened tip, medium size, bright scarlet; flesh pink, not firm, juicy, mild sub-acid, fair; core pink, solid; calyx small, separates easily; seeds many, large. Season, June 4-20; yield 373 quarts per acre.

DIXIE BELL, P.—(W. F. Allen). In bloom May 4-15-20; poor stand; plants small, not vigorous; leaflets small, light; very little disease; runners plentiful; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, ridged, irregular roundish, doubled, large, bright and dark scarlet, pitted; flesh light red, not firm, juicy, sub-acid, fair; core red, solid, large berries hollow; calyx large, persistent; seeds many, large. Season, June 17-20; yield 1,735 quarts per acre.

DOLE, P.—(Station plot). In bloom April 26-May 8-18; fair stand; plants large, vigorous; leaflets medium, dark; little disease; runners plentiful; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, wedge-shaped, cordate, large, bright scarlet, pitted; flesh pink, firm, juicy, mild sub-acid, fair; core pink, solid; calyx medium, adherent, considerably diseased; seeds many, large. Season, June 4-24; yield 5,009 quarts per acre. Especially good for home use.

EARLY BEAUTY, S.—(Station plot). In bloom April 24-May 6-14; good stand; plants small, not vigorous; leaflets small, light; considerable disease; runners plentiful; flowers perfect, small to medium; trusses short, not erect, many flowered; berry uniform, round, cordate, small, rich crimson, slightly pitted; flesh dark red, not firm, juicy, pleasant sub-acid, good; core red, nearly solid; calyx small, separates easily; seeds many, small. Season, June 4-17; yield 1,804 quarts per acre.

EARLY HATHAWAY, S.—(Station plot). In bloom April 24-May 3-18; good stand; plants not large nor vigorous; leaflets small, dark; little disease; runners not plentiful; flowers perfect; trusses short, bending, many flowered; berry uniform, conic, medium size, bright scarlet, slightly pitted; flesh pink, firm, juicy, sub-acid to acid, rather flat, fair; core pink, solid; calyx medium, separates easily. Season, May 31-June 20; yield 3,236 quarts per acre.

E. H. EKEY, S.—(J. G. Harrison & Sons). In bloom May 1-10-18; fair stand; plants small, not vigorous; leaflets medium, dark; very little disease; runners plentiful; flowers perfect, medium to large; trusses short, not erect, many flowered; berry uniform, slightly necked, conic, oblong, large, bright scarlet, slightly pitted; flesh red, not firm, juicy, mild sub-acid, fair; core red, solid; calyx very large, separates easily; seeds many, large. Season, June 4-20; yield 840 quarts per acre.

Elba, S.—(Station plot). In bloom April 20-May 3-18; good stand; plants large and vigorous; leaflets medium to large, moderately dark; little disease; runners abundant; flowers perfect; trusses short, many flowered; berry uniform, long conic, medium size, bright scarlet, pitted; flesh whitish pink, rather soft, juicy, sweet to sub-acid, good; core solid, pink; calyx medium, does not separate easily; seeds not many, large. Season, May 31-June 17; yield 4,636 quarts per acre.

Eleanor, S.—(J. G. Harrison & Sons). In bloom April 26-May 6-18; poor stand; plants small, not vigorous; leaflets large, dark; no disease; runners not plentiful; flowers perfect, large; trusses short, not erect, many flowered; berry uniform, round-conic, medium size; dull crimson, slightly pitted; flesh light red, firm, jucy, mild sub-acid, good; core pink, solid; calyx medium, persistent; seeds many, large. Season, May 31-June 17; yield 498 quarts per acre.

Enormous, P.—(Station plot). In bloom April 27-May 8-22; rather poor stand; plants small, not vigorous; leaflets small, dark; little disease; runners few; flowers imperfect, medium; trusses short, not erect, many flowered; berry uniform, round-conic, wedge-shaped, large, bright dark crimson, slightly pitted; flesh light red, firm, juicy, sub-acid, fair; core pink, solid; calyx large, separates easily; seeds many, small. Season, June 12-24; yield 1,804 quarts per acre.

Excelsior, S.—(Station plot). In bloom April 26-May 6-18; fair stand; plants small, not vigorous; leaflets small, dark; little disease; runners plentiful; flowers perfect, small to medium; trusses short, not erect, many flowered; berry uniform, roundish, oval, small to medium, rich crimson, slightly pitted; flesh dark red, not firm, juicy, mild sub-acid, fair; core red, nearly solid; calyx small, separates easily; seeds many, small. Season, May 31-June 17; yield 653 quarts per acre.

Fairfield, S.—(Station plot). In bloom April 26-May 6-20; good stand; plants not large, not vigorous; leaflets small, light green; little disease; runners not plentiful; flowers perfect, medium; trusses short, not erect, few flowered; berry not uniform, necked, conic, cordate, oblong, medium size, bright scarlet, slightly pitted; flesh red, not firm, juicy, mild sub-acid, sweet, fair; core red, solid; calyx small, separates easily; seeds many, large. Season, May 31-June 20; yield 1,609 quarts per acre.

Gandy x Clyde, No. 1, S.—(Station plot). In bloom May 1-13-18; poor stand; plants small, not vigorous; leaflets small, dark; very little disease; runners few; flowers perfect; trusses short, moderately erect, many flowered; berry uniform, conic, round, blunt, flattened tip, large, bright light scarlet, pitted; flesh light pink, not firm, not juicy, mild sub-acid, fair; core white, solid; calyx medium, separates easily; seeds many, large. Season, June 7-20; yield 809 quarts per acre.

GEN. JOE WHEELER, S.—(W. F. Allen). In bloom April 26-May 8-24; good stand; plants small, not vigorous; leaflets medium, dark; very little disease; runners plentiful; flowers perfect, large; trusses short, not erect, many flowered; berry uniform, slightly necked, conic, pointed, medium size, dark scarlet, slightly pitted; flesh light, not firm, juicy, sub-acid, flat, fair; core red, solid; calyx medium, separates easily; seeds many, small. Season, May 31-June 20; yield 4,045 quarts per acre.

GLEN MARY, S.—(Station plot). In bloom April 26-May 6-20; fair stand; plants small, not vigorous; leaflets small, dark; considerable disease; runners very few; flowers perfect, medium; trusses short, not erect, many flowered; berry not uniform, slightly ridged, roundish, irregular conic, medium to large, bright and dark scarlet, deeply pitted; flesh rich red, not firm, juicy, mild sub-acid, good; core red, solid; calyx large, adherent, diseased; seeds many, large. Season, June 4-24; yield 6,036 quarts per acre. Good for home use.

HALL NO. 2, S.—(J. K. Hall, Marion Station, Md.). In bloom April 26-May 6-20; thin stand; plants small, not vigorous; leaflets large, dark; little disease; runners plentiful; flowers perfect, large; trusses large, not erect, many flowered; berry uniform, round-conic, medium size, dark crimson, deeply pitted; flesh pink, very firm, not juicy, sub-acid, fair; core white, not solid; calyx medium, adherent; seeds many, small. Season, May 31-June 17; yield 1,120 quarts per acre.

HAM, S.—(W. F. Allen). In bloom May 4-13-20; good stand; plants small, not vigorous; leaflets medium, dark; considerable disease; runners not plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry not uniform, conic, irregular, oval, coxcombed, medium to large, very dark crimson, very slightly pitted; flesh, dark red, not firm, not juicy, pleasant, sweet, good; core red, solid; calyx medium, adherent; seeds many, greenish, prominent, very large. Season, June 4-24; yield 1,338 quarts per acre.

HAVERLAND, P.—(Station plot, Kellogg's stock). In bloom April 29-May 6-20; poor stand; plants small, not vigorous; leaflets small, dark; very little disease; runners not plentiful; flowers imperfect, medium; trusses short, not erect, many flowered; berry uniform, necked, long conic, medium size, bright scarlet, slightly pitted; flesh bright red, not firm, juicy, flat sub-acid, fair; core pink, solid; calyx medium, separates easily; seeds many, large. Season, May 31-24; yield 1,929 quarts per acre.

HEFLIN EARLY, P.—(W. F. Allen). In bloom April 26-May 4-16; fair stand; plants small, not vigorous; leaflets medium, light green; very little disease; runners few; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, very slightly necked, somewhat ridged, conic, cordate, sometimes flattened, medium to large, bright scarlet, pitted; flesh light red, not firm, juicy, sub-acid, flat, fair; core pink, not solid; calyx large, adherent; seeds many, large. Season, May 31-June 20; yield 1,836 quarts per acre.

HERO, S.—(Station plot). In bloom May 2-11-22; poor stand; plants not large, moderately vigorous; leaflets medium, dark; very little disease; runners few; flowers perfect; trusses short, bending, many flowered; berry uniform, conic, tip flattened, large, bright dark scarlet, very slightly pitted; flesh bright red, moderately firm, juicy, mild sub-acid, fair; core red, soft; calyx medium, separates fairly easily; seeds many, large. Season, May 31-June 24; yield 1,587 quarts per acre.

HOFFMAN, S.—(W. F. Allen). In bloom April 26-May 6-16; poor stand; plants small, not vigorous; leaflets small, dark; little disease; runners few; flowers perfect; trusses short, not erect, many flowered; berry uniform, round-conic, small to medium, crimson, deeply pitted; flesh bright red, firm, not juicy, sub-acid to acid, fair; core pink, solid; calyx medium, persistent; seeds many, large. Season, June 4-17; yield 840 quarts per acre.

HOWARD, S.—(W. F. Allen). In bloom May 6-18-22; fair stand; plants large, vigorous; leaflets medium, dark; considerable disease; runners plentiful; flowers perfect, large; trusses short, not erect, many flowered; berry not uniform, ridged, round, slightly conical, somewhat flattened, large, scarlet, slightly pitted; flesh light red, firm, not juicy. mild sub-acid, good; core pink, solid; calyx large, separates easily; seeds many, large. Season, June 10-24; yield 3,796 quarts per acre.

HUMMER, S.—(W. F. Allen). In bloom May 1-10-18; good stand; plants medium large, vigorous; leaflets medium, dark; little disease; runners not plentiful; flowers perfect, medium to large; trusses short, not erect, many flowered; berry not uniform, ridged, roundish, irregular, pointed, wedge-shaped, blunt, large, light bright crimson, slightly pitted; flesh light red, firm, not juicy, pleasant mild sub-acid, good; core red, solid; calyx large, separates easily; seeds many, large. Season, June 4-20; yield 4,324 quarts per acre.

ISABELLA, S.—(Station plot). In bloom May 4-15-24; good stand; plants not large, moderately vigorous; leaflets small, light green; little disease; runners abundant; flowers perfect; trusses small, not erect, many flowered; berry uniform, ridged, wedge-shaped, large, bright crimson, slightly pitted; flesh bright red, firm, moderately juicy, sub-acid to acid, fair; core light pink, solid; calyx large, does not separate easily; seeds very many, large. Season, May 31-June 24; yield 5,663 quarts per acre.

JERRY RUSK, S.—(H. L. Hutt, Guelph, Canada). In bloom May 1-10-20; the plants were received so late in the season that only a very poor stand was secured; plants small, not vigorous; leaflets medium, dark; little disease; runners very few; flowers perfect, medium; trusses short, not erect, many flowered; berry not uniform, round, wedge-shaped, blunt, medium to large, crimson, pitted; flesh pinkish red, firm, juicy, sub-acid, fair; core white, solid; calyx medium, persistent; seeds many, large; only a few berries were produced.

JESSIE, S.—(Station plot). In bloom May 1-10-20; good stand; plants small, fairly vigorous; leaflets moderately large, dark; little disease; runners few; flowers perfect; trusses large, erect, many flowered; berry uniform, round-conic, blunt, flattened tip, medium to large, bright scarlet, pitted; flesh bright dark red, not firm, not juicy, mild sub-acid, flat, fair; core pink, not solid; calyx medium; seeds many, large. Season, June 7-24; yield 1,680 quarts per acre.

JOE, S.—(Station plot). In bloom May 1-10-24; good stand; plants small, not vigorous; leaflets small, dark; little disease; runners plentiful; flowers perfect, medium to large; trusses short, not erect, many flowered; berry not uniform, irregular, round-conic, flattened, medium to large, bright and dark crimson, slightly pitted; flesh light red, firm, juicy, mild sub-acid, sweet, fair; core pink, solid; calyx medium, separates easily; seeds many, large. Season, June 4-24; yield 1,773 quarts per acre.

JOHNSON, S.—(Station plot). In bloom April 26-May 4-16; fair stand, plants small, not vigorous; leaflets small, dark; very little disease; runners plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, necked, round-conic, small, dull scarlet, slightly pitted; flesh red, not firm, not juicy, mild sub-acid, sweet, musky, fair; core pink, solid; calyx medium, separates easily; seeds many, large. Season, May 31-June 20; yield 591 quarts per acre.

KANSAS, P.—(Station plot). In bloom May 6-15-18; good stand; plants large, vigorous; leaflets medium, dark; considerable disease; runners abundant; flowers imperfect, medium; trusses short, not erect, many flowered; berry uniform, ridged, round, wedge-shaped, blunt, large, bright scarlet and crimson, slightly pitted; flesh light red, firm, juicy, pleasant sub-acid, good; core pink, solid; calyx large, persistent; seeds many, large. Season, June 10-24; yield 5,911 quarts per acre.

King Philip, S.—(J. G. Harrison & Sons). In bloom April 26-May 18-24; fair stand; plants large, vigorous; leaflets large, dark; considerable disease; runners plentiful; flowers perfect; trusses large, not erect, many flowered; berry not uniform, roundish, irregular, wedge-shaped, large, bright scarlet, pitted; flesh pink, firm, juicy, sub-acid, sweet, good; core pink, solid; calyx large, diseased, separates easily; seeds many, large. Season, June 14-24; yield 964 quarts per acre.

Kittie Rice, P.—(Station plot). In bloom May 4-15-20; fair stand; plants large, vigorous; leaflets medium, dark; little disease; runners plentiful; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, round-conic, flattened, large, bright crimson, slightly pitted; flesh red, firm, juicy, sub-acid, fair; core pink, solid; calyx large, persistent; seeds many, large. Season, June 16-24; yield 1,617 quarts per acre.

Kuropatkin, S.—(William Belt x T. W. Matthews, Station plot). In bloom April 24-May 3-18; good stand; plants medium, moderately vigorous; leaflets medium, dark; little disease; runners abundant; flowers perfect; trusses short, erect, many flowered; berry uniform, very slightly ridged, round-conic, tip slightly flattened, below medium, bright scarlet to light crimson, slightly pitted; flesh red, moderately firm, moderately juicy, sub-acid to sweet, fair; core not solid; calyx medum, does not separate easily; seeds very many, small. Season, May 31-June 17; yield 4,387 quarts per acre.

Lady Thompson, S.—(Station plot). In bloom May 1-14-22; fair stand; plants large, vigorous; leaflets large, moderately dark; little disease; runners plentiful; flowers perfect; trusses large, erect, many flowered; berry uniform, conic, flattened tip, medium size, bright scarlet, pitted; flesh light red, firm, juicy, sub-acid to acid, fair; core white, solid; calyx medium, fairly persistent; seeds many, large. Season, May 31-June 24; yield 6,098 quarts per acre.

Latest, P.—(Station plot). In bloom May 4-10-20; fair stand; plants not large, not vigorous; leaflets medium, dark; little disease; runners very few; flowers imperfect, medium size; trusses short, erect, many flowered; berry uniform, slightly ridged, conic, wedge-shaped, flattened, medium to large, scarlet, pitted; flesh light pink, not firm, juicy, pleasant mild sub-acid, sweet, good; core white, solid; calyx large, adherent; seeds many, large. Season, June 12-24; yield 3,350 quarts per acre.

Leaver, S.—(Station plot). In bloom May 4-15-20; fair stand; plants small, not vigorous; leaflets medium, dark; considerable disease: runners few; flowers perfect, small to medium; trusses short, not erect, many flowered; berry uniform, roundish, restricted point, medium to large, dull crimson, slightly pitted; flesh light red, not firm, juicy, pleasant mild sub-acid, good; core pink, not solid; calyx medium, separates easily, diseased; seeds many, large. Season, June 17-24; yield 809 quarts per acre.

LOUIS HUBACH, P.—(Station plot). In bloom April 26-May 4-16; rather poor stand; plants small, not vigorous; leaflets small, dark; little disease; runners plentiful; flowers imperfect, small to medium; trusses short, erect, many flowered; berry uniform, round, conic, small, dull crimson, slightly pitted; flesh red, firm, juicy, sub-acid to acid, fair; core red, solid; calyx medium, adherent; seeds many, large. Season, May 31-June 20; yield 1,338 quarts per acre.

LOVETT, S.—(Station plot, Kellogg's stock). In bloom May 4-15-20; thin stand; plants small, not vigorous; leaflets small, dark; little disease; runners not plentiful; flowers perfect, large; trusses short, not erect, many flowered; berry not uniform, slightly ridged, round-conic, wedge-shaped, medium to large, dark crimson, slightly pitted; flesh a good red, firm, juicy, acid, flat, fair; core red, solid; calyx large, persistent; seeds many, large. Season, June 4-24; yield 1,960 quarts per acre.

LYON, P.—(Station plot). In bloom May 2-13-20; good stand; plants small, not vigorous; leaflets small, dark; little disease; runners plentiful; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, round-conic, wedge-shaped, medium, very attractive, light and dark crimson, slightly pitted; flesh bright red, firm, juicy, mild sub-acid, flat; core red, solid; calyx medium, separates easily; seeds many, large. Season, May 31-June 24; yield 8,992 quarts per acre. Very productive, but berries are not large.

MAJOR STOESSEL, S.—(Seedling of Gandy x Clyde, Station plot). In bloom May 4-13-20; rather poor stand; plants small, not vigorous; leaflets medium, dark; little disease; runners few; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, round, blunt, very large, bright crimson, slightly pitted; flesh light bright red, firm, not juicy, pleasant sub-acid, fair; core red, solid: calyx medium, persistent; seeds many, large. Season, June 14-20; yield 311 quarts per acre.

MAMMOTH, P.—(Station plot). In bloom May 4-13-16; fair stand (hills); plants large, vigorous; leaflets medium, dark; very little disease; runners few; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, slightly ridged, irregular, roundish, coxcombed, very large, attractive bright and dark crimson, slightly pitted; flesh light red, not firm, juicy, mild sub-acid, fair; core red, solid; calyx large, persistent; seeds many, large. Season, June 14-24; yield 1.587 quarts per acre. Especially good for local trade.

MAMMOTH CLUSTER, S.—(H. L. Hutt). In bloom May 1-10-20; very few plants, received very late in season; plants small, not vigorous; leaflets small, dark; little disease; runners few; trusses short, not erect, many flowered; berry not uniform, roundish, oblong, medium size, very dark crimson, slightly pitted; flesh dark red, not firm, juicy, very mild sub-acid, fair; core red, solid; calyx small, separates easily, badly diseased; seeds many, small; very few berries produced. Season, June 10-20.

MARIE, P.—(Station plot). In bloom May 4-15-22; fair stand; plants small, not vigorous; leaflets small, dark; little disease; runners few; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, slightly ridged, round, irregular, cordate, medium to large, dull dark scarlet, slightly pitted; flesh red, not firm, juicy, mild sub-acid, fair; core red, solid; calyx large, persistent; seeds many, small. Season, June 4-24; yield 3,702 quarts per acre.

MARK HANNA, P.—(Station plot). In bloom May 6-18-22; poor stand; plants large, not vigorous; leaflets small, dark; very little disease; runners none or few; flowers imperfect, medium; trusses short, not erect, many flowered; berry uniform, slightly ridged, uneven conic to wedge-shaped, medium to large, light and dark crimson, slightly pitted; flesh rich red, not firm, juicy, acid to sub-acid, fair; core pink, solid; calyx large, adherent; seeds many, small. Season, June 14-20; yield 964 quarts per acre.

MARSDEN PERRY, S.—(W. F. Allen). In bloom April 26-May 7-20; fair stand; plants small, not vigorous; leaflets small, dark; considerable disease; runners few; flowers perfect; trusses short, erect, many flowered; berry uniform, conic, flattened tip, medium size, dull crimson, pitted; flesh light red, not firm, not juicy, sub-acid, fair; core pink, not solid; calyx medium, separates easily; seeds many, large. Season, June 7-17; yield 1,836 quarts per acre.

MAY KING, S.—(W. F. Allen). In bloom May 1-13-20; fair stand; plants large, vigorous; leaflets medium, dark; very little disease; runners plentiful; flowers perfect; trusses short, erect, many flowered; berry uniform, round-conic, medium size, bright scarlet, pitted; flesh light red, firm, juicy, sub-acid to acid, fair; core white, solid; calyx medium, persistent; seeds many, large. Season, June 4-20; yield 2,551 quarts per acre.

McKINLEY, S.—(J. G. Harrison & Sons). In bloom April 26-May 6-18; fair stand; plants large, vigorous; leaflets large, dark; considerable disease; runners few; flowers perfect; trusses short, not erect, many flowered; berry not uniform, slightly ridged, round-conic, flattened tips, medium to large, bright scarlet to crimson, slightly pitted; flesh white, firm, not juicy, mild sub-acid, fair; core pink, not solid; calyx medium, adherent; seeds many, large. Season, June 7-20; yield 1,431 quarts per acre.

MEADE, S.—(W. F. Allen). In bloom April 27-May 8-18; fair stand; plants large, vigorous; leaflets medium, dark; very little disease; runners plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, roundish, blunt, large, attractive scarlet, slightly pitted; flesh light red, firm, juicy, pleasant mild sub-acid, good; core red, solid; calyx large, separates easily; seeds many, large. Season, June 15-24; yield 2,488 quarts per acre.

MICHEL, S.—(Station plot). In bloom April 24-May 4-14; good stand; plants small, not vigorous; leaflets small, dark; much disease; runners plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, necked, round-pointed, small, bright scarlet, slightly pitted; flesh light pink, not firm, juicy, mild sub-acid, sweet, good; core pink, solid; calyx medium, separates easily; seeds many, large. Season, May 31-June 17; yield 1,338 quarts per acre.

MIDNIGHT, S.—(Station plot). In bloom May 1-15-26; good stand; plants small, not vigorous; leaflets small, dark; considerable disease; runners plentiful; flowers perfect, medium; trusses short, not many flowered; berry not uniform, conic, flattened, coxcombed, large, bright light crimson, slightly pitted; flesh white, pleasant sub-acid, sweet, good; core white, solid; calyx medium, persistent, seeds many, large. Season, June 12-24; yield 3,329 quarts per acre.

MINUTE MAN, P.—(Station plot). In bloom May 2-13-18; good stand; plants small, not vigorous; leaflets small, dark; little disease; runners not plentiful; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, roundish, slightly conic, flattened tip, large, attractive bright dark scarlet, slightly pitted; flesh light red, not firm, not juicy, mild sub-acid, fair; core red, solid; calyx large, persistent; seeds many, large. Season, June 10-24; yield 3,982 quarts per acre. One of the most attractive and extra good for home market.

MRS. MARK HANNA, S.—(Station plot). In bloom May 2-11-20; fair stand; plants large, vigorous; leaflets medium, dark; little disease; runners plentiful; flowers perfect, medium to large; trusses large, not erect, many flowered; berry uniform, slightly ridged, short conic, medium to large, bright crimson, slightly pitted; flesh light red, firm, juicy, insipid, sub-acid, fair; core pink, solid; calyx medium, separates easily, diseased; seeds many, large. Season, June 12-24; yield 2,240 quarts per acre.

New Globe, S.—(J. G. Harrison & Sons). In bloom April 27-May 8-16; fairly good stand; plants large, vigorous; leaflets medium, dark; considerable disease; runners plentiful; flowers perfect, medium; trusses large, moderately erect, many flowered; berry not uniform, conic, roundish, irregular, large, dark scarlet and bright crimson, slightly pitted; flesh light red, not firm, juicy, mild sub-acid, fair; core pink, solid; calyx medium to large, separates easily; seeds many, large. Season, June 8-24; yield 3,609 quarts per acre.

New Home, S.—(Station plot). In bloom May 8-18-26; fair stand; plants small, moderately vigorous; leaflets small, light green; little disease; runners few; flowers perfect; trusses short, not erect, many flowered; berry not uniform, somewhat ridged, round-conic, flattened, often blunt, very large, crimson, slightly pitted; flesh red, firm, juicy, sub-acid, fair; core pink, solid; calyx large, separates easily; seeds many, large. Season, June 16-24; yield 1,369 quarts per acre.

New York, S.—(J. G. Harrison & Sons). In bloom April 29-May 6-16; fair stand; plants large, vigorous; leaflets large, dark; very little disease; runners not plentiful; flowers perfect, large; trusses short, not erect, many flowered; berry not uniform, slightly ridged, conic, flattened tip, coxcombed, medium to large, bright and dark scarlet, pitted; flesh pink, firm, not juicy, mild sub-acid, good; core pink, not solid; calyx large, adherent; seeds many, large. Season, June 4-17; yield 1,369 quarts per acre.

Nick Ohmer, S.—(Station plot). In bloom May 1-13-22; fair stand; plant large, vigorous; leaflets medium, dark; little disease; runners few; flowers perfect, medium to large; trusses large, erect, many flowered; berry uniform, slightly ridged, round-conic, pointed, medium to large, attractive bright crimson, slightly pitted; flesh light red, firm, juicy, pleasant mild sub-acid, nearly sweet, good; core white, solid; calyx very large, persistent; seeds very many, large. Season, June 12-24; yield 1,866 quarts per acre.

Ninety-Six, S.—(Station plot). In bloom May 3-15-24; poor stand (hills); plants large, vigorous; leaflets medium large, dark; very little disease; runners few; flowers perfect; trusses short, not erect, many flowered; berry not uniform, conic, wedge-shaped to coxcombed, very irregular, large, dark crimson, pitted; flesh red, moderately firm, juicy, mild sub-acid, flat, fair; core solid, light pink; calyx medium, does not separate easily; seeds many, large. Season, June 7-24; yield 2,022 quarts per acre.

Oak Early, S.—(J. G. Harrison & Sons). In bloom April 27-May 8-16; good stand; plants small, not vigorous; leaflets small, dark; little disease; runners plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, necked, round-conic, medium size, bright crimson, slightly pitted; flesh red, not firm, juicy, mild sub-acid, sweet, fair; core red, solid; calyx small, separates easily; seeds many, large. Season, May 31-June 17; yield 2,147 quarts per acre.

OLIVES PRIDE, S.—(Station plot). In bloom May 2-13-22; fair stand; plants small, not vigorous; leaflets small, light; very little disease; runners few; flowers perfect, small to medium; trusses short, not erect, many flowered; berry not uniform, slightly ridged, conic, wedge-shaped, flattened, medium size, bright dark scarlet, slightly pitted; flesh bright red, firm, juicy, sub-acid, nearly sweet, fair; core pink, solid; calyx large, separates moderately easily; seeds many, small. Season, June 12-17; yield 622 quarts per acre.

OOM PAUL, S.—(Station plot). In bloom May 1-23-20; good stand; plants large, vigorous; leaflets medium, dark; little disease; runners not plentiful; flowers perfect, medium to large; trusses large, bending, many flowered; berry not uniform, slightly ridged, cordate, irregularly flattened, coxcombed, very large, bright and dark crimson; slightly pitted; flesh light red, firm, not juicy, mild sub-acid, sweet, good; core red, solid; calyx large, adherent; seeds many, large. Season, June 4-24; yield 1,338 quarts per acre.

PARSONS, S.—(Station plot). In bloom May 4-11-24; good stand; plants small, not vigorous; leaflets small, dark; little disease; runners plentiful; flowers perfect, medium to large; trusses short, bending, many flowered; berry not uniform, broad conic, slightly ridged, wedge-shaped, medium to large, bright scarlet, slightly pitted; flesh light red, firm, juicy, mild sub-acid, fair; core pink, solid; calyx medium, separates easily; seeds many, large. Season, June 14-24; yield 4,543 quarts per acre.

POCOMOKE, S.—(Station plot). In bloom May 4-18-26; good stand; plants small, not vigorous; leaflets small, dark; very little disease; runners plentiful; flowers perfect; trusses short, not erect, many flowered; berry uniform, slightly ridged, round, blunt, flattened tip, large, bright and dark crimson, slightly pitted; flesh bright red, firm; juicy, mild sub-acid, fair; core pink, not solid; calyx medium, separates easily; seeds many, small. Season, June 4-24; yield 5,663 quarts per acre.

. PORTO RICO, S.—(Station plot). In bloom April 26-May 4-16; poor stand; plants small, not vigorous; leaflets small, dark; little disease; runners few; flowers perfect; trusses moderately large, erect, many flowered; berry uniform, ridged, conic, blunt, flattened, medium to large, bright crimson, pitted; flesh pink, not firm, not juicy, mild sub-acid, fair; core white, solid; calyx medium, adherent; seeds many, large. Season, June 7-24; yield 1,244 quarts per acre.

Pride of Cumberland, S.—(Station plot). In bloom May 3-15-26; good stand; plants large, vigorous; leaflets small, dark; little disease; runners plentiful; flowers perfect; trusses moderately large, erect, many flowered; berry uniform, round-conic, blunt, medium to large, bright scarlet, slightly pitted; flesh pink, firm, juicy, sub-acid, good; core pink, solid; calyx medium to large, separates easily; seeds many, large. Season, June 4-24; yield, 4,169 quarts per acre.

Reliance, S.—(W. F. Allen). In bloom April 26-May 6-18; rather poor stand; plants small, not vigorous; leaflets small, dark; little disease; runners very few; flowers perfect; trusses small, erect, many flowered; berry not uniform, round-conic, blunt, flattened tip, medium size, bright scarlet, rather deeply pitted; flesh bright red, not firm, not juicy, sub-acid to acid, fair; core pink, not solid; calyx medium, persistent; seeds many, large. Season, June 4-20; yield 715 quarts per acre.

Repeater, S.—(H. L. Hutt, Guelph, Canada). In bloom May 3-13-20; received very late in the season, and the stand was very poor; plants small, not vigorous; leaflets medium, dark; very little disease; runners few; flowers perfect, medium; trusses short, not erect, many flowered; berry not uniform, conic, flattened, rough, medium size, bright crimson, pitted; flesh red, not firm, juicy, sub-acid to acid, fair; core pink, solid; calyx medium, adherent; seeds many, small; only a few fruits produced.

Ridgeway, S.—(W. F. Allen). In bloom May 3-13-24; poor stand; plants small, not vigorous; leaflets small, dark; very little disease; runners few; flowers perfect, medium to large; trusses very short, not erect, many flowered; berry uniform, slightly ridged, round-conic, blunt, medium size, bright crimson, slightly pitted; flesh light red, firm, juicy, mild pleasant sub-acid, good; core pink, solid; calyx medium to large, adherent, dry; seeds many, large. Season, June 14-24; yield 1,244 quarts per acre.

Rio, S.—(J. G. Harrison & Sons). In bloom April 24-May 4-18; poor stand; plants small, not vigorous; leaflets medium, dark; very little disease; runners abundant; flowers perfect, large; trusses short, not erect, many flowered; berry uniform, slightly necked and ridged, conic, medium size, dull crimson, slightly pitted; flesh pink, firm, juicy, sub-acid, sweet, good; core, white, solid; calyx medium, separates easily; seeds many, small. Season, May 31-June 17; yield 1,213 quarts per acre.

Rough Rider, S.—(J. G. Harrison & Sons). In bloom May 4-11-16; very poor stand; plants small, not vigorous; leaflets small, dark; little disease; runners few; flowers perfect, medium; trusses short, not erect, many flowered; berry not uniform, conic, round, flattened end, medium to large, scarlet and dark crimson, slightly pitted; flesh dark red, not firm, juicy, mild sub-acid, fair; core pink, solid; calyx small, adherent; seeds many, small. Season, June 16-20; yield 155 quarts per acre.

SALEM, S.—(Station plot). In bloom May 4-11-22; good stand; plants small, not vigorous; leaflets small, light; considerable disease; runners plentiful; flowers perfect, medium; trusses short, erect, many flowered; berry not uniform, ridged, roundish, wedge-shaped, blunt, medium to large, dull crimson, slightly pitted; flesh red, firm, moderately fine, juicy, sub-acid to acid, flat, fair; core red, solid; calyx large, adherent; seeds many, small. Season, June 4-24; yield 4,418 quarts per acre.

SAMPLE, P.—(Station plot). In bloom May 4-18-24; good stand; plants large, vigorous; leaflets medium, dark; considerable disease; runners plentiful; flowers imperfect, medium; trusses short, bending, many flowered; berry not uniform, slightly ridged, round-conic, flattened, large, bright crimson, slightly pitted; flesh rich red, not firm, juicy, mild sub-acid, good; core pink, solid; calyx large, adherent, diseased; seeds many, large. Season, June 10-24; yield 5,663 quarts per acre. Good for home use.

SEAFORD, P.—(Station plot). In bloom May 4-10-22; fair stand; plants not large, not vigorous; leaflets medium, light green; very little disease; runners plentiful; flowers imperfect, large; trusses large, not erect, many flowered; berry not uniform, slightly necked and ridged, conic, wedge-shaped, blunt, flattened tip, medium to large, bright crimson, pitted; flesh dark red, not firm, juicy, sub-acid, flat, fair; core pink, solid; calyx medium to large, persistent; seeds many, large. Season, June 4-24; yield 3,733 quarts per acre.

SENATOR DUNLAP, S.—(J. G. Harrison & Sons). In bloom April 26-May 4-22; fair stand; plants small, not vigorous; leaflets small, dark; very little disease; runners few; flowers perfect, large; trusses short, not erect, many flowered; berry uniform, necked, slightly ridged, conic, oblong, medium size, dark crimson, pitted; flesh red, not firm. not juicy, sub-acid, flat, fair; core pink, not solid; calyx medium, separates easily; seeds many, large. Season, May 31-June 20; yield 1,431 quarts per acre.

SOMERSET MAID, S.—(W. F. Allen). In bloom April 24-May 6-18; thin stand; plants small, not vigorous; leaflets small, dark; very little disease; runners not plentiful; flowers perfect, large; trusses short, bending, many flowered; berry not uniform, slightly ridged, conic, irregular, large, bright crimson, very slightly pitted; flesh light red, not firm, juicy, mild sub-acid, fair; core red, not solid; calyx large, separates easily; seeds many, large. Season, June 4-17; yield 1,058 quarts per acre.

SPRINGDALE, S.—(Station plot). In bloom April 29-May 6-22; good stand; plants small, not vigorous; leaflets medium, dark; little disease; runners few; flowers perfect, small to medium; trusses large, erect, many flowered; berry uniform, irregular, roundish, flattened, medium to large, light crimson, slightly pitted; flesh light red, not firm, juicy, lively pleasant mild sub-acid, good; core red, solid; calyx large, separates easily; seeds many, small. Season, May 31-June 20; yield 1,609 quarts per acre.

STAKELEY, P.—(Station plot). In bloom May 2-13-20; fair stand; plants small, not vigorous; leaflets small, dark; little disease; runners plentiful; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, slightly ridged, conic, wedge-shaped, restricted point, small to large, dull crimson, slightly pitted; flesh rich red, firm, juicy, flat, fair; core pink, solid; calyx large, separates easily; seeds many, small. Season, May 31-June 24; yield 6,411 quarts per acre.

STELLA, P.—(Station plot). In bloom May 6-15-20; fair stand; plants small, not vigorous; leaflets medium, dark; very little disease; runners plentiful; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, slightly ridged, roundish, irregularly flattened, medium to large, crimson, slightly pitted; flesh light red, firm, juicy, mild sub-acid, fair; core pink, solid; calyx large, persistent; seeds many, small. Season, June 17-24; yield 1,929 quarts per acre.

STEVENS LATE CHAMPION, S.—(W. F. Allen). In bloom May 4-15-26; fair stand; plants small, not vigorous; leaflets medium, light green; little disease; runners plentiful; flowers perfect, large; trusses short, not erect, many flowered; berry not uniform, hard nosed, ridged, thick irregular wedge-shaped, coxcombed, large, bright scarlet, slightly pitted; flesh light pink, not firm, juicy, pleasant sub-acid, fair; core white, solid; calyx large, persistent; seeds many, large. Season, June 14-24; yield 1,804 quarts per acre.

SUCCESS, S.—(H. L. Hutt, Guelph, Canada). In bloom May 4-10-20; poor stand; plants large, vigorous; leaflets large, dark; very little disease; runners plentiful; flowers perfect, large; trusses very short, not erect, many flowered; berry uniform, round-conic, medium to large, dull scarlet, moderately pitted; flesh light red, firm, juicy, sub-acid, fair; core pink, solid; calyx medium, separates easily; seeds many, large. Season, June 7-17; yield 311 quarts per acre.

SUPERIOR, S.—(J. G. Harrison & Sons). In bloom April 26-May 4-20; good stand; plants small, not vigorous; leaflets large, dark; very little disease; runners plentiful; flowers perfect, large; trusses short, not erect, many flowered; berry not quite uniform, slightly ridged, conic, blunt, flattened tip, medium to large, bright and dark scarlet, slightly pitted; flesh light red, firm, juicy, mild sub-acid, sweet, good; core pink, solid; calyx large, adherent; seeds many, large. Season, May 31-June 24; yield 3,298 quarts per acre.

SURPRISE, S.—(Station plot). In bloom April 26-May 9-24; good stand; plants small, not vigorous; leaflets small, light; very little disease; runners plentiful; flowers perfect; trusses medium, large, erect, many flowered; berry not uniform, slightly ridged, round-cordate, oblong, blunt, flattened, medium size, bright scarlet, slightly pitted; flesh pink, firm, juicy, mild sub-acid, good; core light red, soft; calyx medium, separates easily; seeds many, small. Season, May 31-June 24; yield 6,411 quarts per acre.

SUTHERLAND, P.—(Station plot). In bloom May 4-15-20; fair stand; plants small, not vigorous; leaflets small, dark; little disease; runners plentiful; flowers imperfect, small to medium; trusses short, not erect, many flowered; berry uniform, slightly ridged, uneven, conic, blunt, medium to large, bright attractive crimson, slightly pitted; flesh rich red, not firm, juicy, mild sub-acid, nearly sweet, good; core red, not solid; calyx large, adherent; seeds many, large. Season, June 10-24; yield 2,613 quarts per acre. Good for home use.

TENNESSEE, S.—(Station plot). In bloom May 1-11-26; good stand; plants small, not vigorous; leaflets small, light green; very little disease; runners plentiful; flowers perfect; trusses short, not erect, many flowered; berry not uniform, ridged, conic, wedge-shaped, blunt, flattened, fasciated, large, bright scarlet, slightly pitted; flesh bright red, firm, juicy, mild sub-acid, good; core pink, solid; calyx large, persistent; seeds many, large. Season, May 31-June 24; yield 6,658 quarts per acre.

THOMPSON EARLIEST, S.—(Station plot). In bloom April 24-May 4-14; good stand; plants small, not vigorous; leaflets small, dark; considerable disease; runners plentiful; flowers perfect, medium; trusses short, bending, many flowered; berry uniform, slightly necked, roundish cordate, small to medium, dull scarlet, pitted; flesh light pink. not firm, juicy, mild sub-acid, fair; core pink, solid; calyx small, separates readily, considerably diseased; seeds many, large. Season, May 31-June 17; yield 1,369 quarts per acre.

THOMPSON, 203, S.—(Station plot). In bloom April 26-May 6-14; poor stand; plants small, not vigorous; leaflets small, light green; very little disease; runners plentiful; flowers perfect, small to medium; trusses short, not erect, many flowered; berry uniform, roundish, small to medium, rich crimson, slightly pitted; flesh light red, not firm, not juicy, subacid, flat, fair; core red, solid; calyx small, adherent, somewhat diseased; seeds many, large. Season, May 31-June 17; yield 622 quarts per acre.

THOMPSON, 501, S.—(Station plot). In bloom April 26-May 6-16; fairly good stand; plants large, vigorous; leaflets medium, dark; very little disease; runners plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry not uniform, slightly ridged, round-conic, irregular, small to large, rich scarlet, pitted; flesh light red, very soft, mild sub-acid, fair; core light red, solid; calyx medium, adherent, diseased; seeds many, large. Season, June 14-24; yield 1,462 quarts per acre.

THOMPSON, 502, S.—(Station plot). In bloom April 24-May 4-20; good stand; plants small, not vigorous; leaflets small, light; considerable disease; runners plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, cordate, small to medium, scarlet, slightly pitted; flesh rich red, firm, juicy, sub-acid, fair; core red, solid; calyx medium, adherent; seeds many, small. Season, May 31-June 17; yield 2,458 quarts per acre.

TILGHMAN FAVORITE, P.—(Station plot). In bloom May 2-14-22; good stand; plants moderately large, vigorous; leaflets medium, dark; considerable disease; runners not plentiful; flowers imperfect; trusses moderately large, not erect, many flowered; berry not uniform, slightly ridged, hard nosed, long-conic, end very slightly flattened, large, bright dark scarlet, not pitted; flesh pink, firm, moderately juicy, acid to sub-acid, fair; core solid, light pink; calyx very large, persistent; seeds many, large. Season, June 4-24; yield 4,511 quarts per acre.

TOGO SEEDLING, No. 1, S.—(Second generation seedling of Johnson x Tennessee, Station plot). In bloom April 26-May 6-16; poor stand; plants small. not vigorous; leaflets small, dark; very little disease; runners not plentiful; flowers perfect, small to medium; trusses very short, not erect, many flowered; berry irregularly ridged, roundish, wedge-shaped, medium to large, bright crimson, slightly pitted; flesh light rich red, not firm, juicy, mild sub-acid, fair; core red, not solid; calyx medium, separates easily; seeds many, large. Season, June 4-17; yield 342 quarts per acre.

TOGO SEEDLING, No. 2, S.—(Second generation seedling of Johnson x Tennessee, Station plot). In bloom April 26-May 4-20; good stand; plants small, vigorous; leaflets small, dark; very little disease; runners plentiful; flowers perfect, medium to large; trusses short, not erect, many flowered; berry uniform, slightly necked and ridged, round-conic, flattened, large, bright scarlet, pitted; flesh rich red, not firm, juicy, mild sub-acid, good; core pink, solid; calyx small, persistent; seeds many, large. Season, May 31-June 24; yield 1,751 quarts per acre. Good for home use.

TOGO SEEDLING, No. 3, S.—(Second generation seedling of Johnson x Tennessee, Station plot). In bloom April 26-May 4-20; fair stand; plants small, not vigorous; leaflets small, light green; little disease; runners plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, slightly ridged, oval, flattened tip, medium to large, bright attractive scarlet shaded to crimson, slightly pitted; flesh rich red, not firm, juicy, pleasant mild sub-acid, good; core red, solid; calyx small, persistent; seeds many, large. Season, June 14-20; yield 693 quarts per acre.

TOGO SEEDLING, No. 4, S.—(Second generation seedling of Johnson x Tennessee, Station plot). In bloom May 4-13-20; poor stand; plants small, not vigorous; leaflets medium, dark; very little disease; runners not plentiful; flowers perfect, medium to large; trusses short, not erect, many flowered; berry not uniform, slightly necked and ridged, round, conic, wedge-shaped, medium to large, rich dull crimson, slightly pitted; flesh rich red, firm, juicy, pleasant mild sub-acid, good; core red, solid; calyx large, separates easily; seeds many, large. Season, June 17-24; yield 373 quarts per acre.

TUBBS, S.—(Station plot). In bloom April 24-May 4-16; good stand; plants small, not vigorous; leaflets small, dark; little disease; runners plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, cordate, flattened, small to medium, bright scarlet, slightly pitted; flesh white, not firm, not juicy, pleasant sub-acid, nearly sweet, good; core pink, solid; calyx small, separates easily; seeds many, small. Season, May 31-June 17; yield 2,302 quarts per acre.

UNCLE JIM, S.—(Station plot). In bloom April 27-May-4-14; good stand; plants large, vigorous; leaflets large, dark; little disease; runners plentiful; flowers perfect; trusses large, moderately erect; berry not uniform, much ridged, conic, long pointed, coxcombed, medium to large, scarlet to dull crimson, slightly pitted; flesh light pink, firm, not juicy, sub-acid to sweet, fair; core pink, quite solid; calyx large, separates easily; seeds many, large. Season, June 7-20; yield 3,609 quarts per acre.

WILD WONDER, S.—(W. F. Allen). In bloom April 26-May 8-16; good stand; plants small, not vigorous, leaflets small, dark; considerable disease; runners plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, round-conic, small, bright crimson, slightly pitted; flesh red, firm, juicy, mild sub-acid, nearly sweet, fair; core red, solid; calyx small, persistent; seeds few, large. Season, May 31-June 20; yield 1,307 quarts per acre.

WOLVERTON, S.—(W. F. Allen). In bloom May 1-11-20; good stand; plants small, moderately vigorous; leaflets medium, dark; very little disease; runners plentiful; flowers perfect, medium to large; trusses short, not erect, many flowered; berry not uniform, conic, wedge-shaped, coxcombed, very large, rich bright crimson, slightly pitted; flesh dark red, not firm, juicy, mild sub-acid, fair; core red, solid; calyx medium to large, separates easily; seeds many, large. Season, June 17-24; yield 3,732 quarts per acre.

YALU, S.—(Johnson x Star, Station plot). In bloom April 22-May 2-14; good stand; plants small, not vigorous; leaflets large, medium dark; no disease; runners not plentiful; flowers perfect; trusses very short, not erect, many flowered; berry uniform, slightly ridged, conic, medium size, dull crimson, pitted; flesh light red, not firm, moderately juicy, mild sub-acid, fair; core pink, not solid; calyx medium, persistent; seeds many, small. Season, May 31-June 20; yield 1,431 quarts per acre.

YANT, S.—(Station plot). In bloom May 1-13-20; good stand; plants very large, vigorous; leaflets large, very dark; little disease; runners not plentiful; flowers perfect; trusses moderately large, erect, many flowered; berry not uniform, ridged, round-conic, wedge-shaped, coxcombed, very large, bright scarlet to crimson, pitted; flesh light pink, quite firm, juicy, sub-acid, good; core light pink, solid; calyx medium to large; adherent; seeds many, large. Season, June 7-20; yield 3,920 quarts per acre.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 125. FEBRUARY, 1908.

NUT GROWING IN MARYLAND.

By C. P. Close.

The principal objects of this bulletin are, to make a report on the nut survey made in the summer of 1907, to give directions for propagating and planting Persian walnuts and pecans, and especially for top grafting or budding black walnut trees and unfruitful or inferior Persian walnut trees to improved varieties of the Persian walnut, to describe desirable varieties of Persian walnuts and pecans, and to encourage the people of the State to plant nut trees on a commercial basis.

REPORT OF THE NUT SURVEY.

In order to obtain information on the present status of nut growing in all parts of Maryland the writer sent out letters of inquiry to every man or woman who owned a nut tree of any kind so far as he was able to learn. Nearly one hundred people were enough interested to reply more or less minutely to the various questions asked. From nearly every portion of the State the native chestnut, black walnut and hickory, are reported. Occasionally an extra large and sweet native chestnut is mentioned. A few magnificent black walnuts and hickories of thin shell and large sweet kernel have been located. Other natives of less importance abound such as the butternut, hazel nut, chincapin and beach nut. From one place the wild pecan is reported. Scattered efforts have been made to improve a very few of the native nuts of special merit and some effort has been made to introduce cultivated nuts from other supposedly more favorable climes. Being so favorably situated as she is, on the boundary line between the severe cold of the North, and the intense heat of the South, Maryland may well aspire to add the new industry of nut production to her varied resources. A few old pioneer Persian walnut and pecan trees have blazed the way, and extensive orchards of the hardiest of improved varieties of these nuts will surely follow.

Since the state is of such peculiar shape and varies in elevation from sea level in the east, to quite respectable mountains in the west, it is well to divide it into sections of similar soil and climatic conditions and discuss each section briefly.

In the two westermost counties of high elevation and winter temperature dropping occasionally to 20 degrees below zero, all of the native nuts succeed well and thousands of pounds of native chestnuts are shipped from there annually. One man alone gathers and sells a hundred bushels per year. Very little effort has been made to grow improved chestnuts or Persian walnuts and only a few of these trees were reported. In the third county of Western Maryland about 75 Persian walnut trees were reported and most of them are doing well without even ordinary attention in a winter temperature which occasionally reaches ten degrees below zero. Insects and diseases do not trouble the trees to any extent and the cold of winter does little injury. Most of these trees seem to be seedlings not over 30 years old except one which has reached the age of 80 years. In most instances the nuts produced are reported to be equal to and even better, than those purchased in the market. Seedling trees are reported to produce true to type and begin to yield at from six to nine years of age. The yield varies from a few nuts to one peck, or even one bushel per tree. A certain tree now 12 years old has averaged one bushel of nuts annually for three or four years.

One tree cleft grafted on black walnut produced 300 nuts the third year from grafting and more than 1,000 nuts the fourth year. The man who did this grafting thinks that black walnut stock promotes earlier and more abundant yields and that trees on such stocks stand the winter better than those on Persian walnut stocks. Another correspondent believes that trees on black walnut stocks do not stand the winter well. He crown grafts on Persian walnut seedlings only three inches high.

The only nut tree nursery reported in the state is in this section and contains about 1,200 young trees.

Pecans are said to grow slowly and bear at 15 years, there was, however, only one report on pecans.

There was only one report on improved chestnuts and in this the owner says that after ten years he gave up in disgust.

The section north of the District of Columbia and extending east to the Chesapeake Bay, is more favorable for nut culture because of a milder climate than that of Western Maryland. From 75 to 100 Persian walnut trees less than 25 years old are reported in this section. There are also a few old ones. One old land-mark planted about 1850 or earlier and killed by the blizzard of 1900, bore as much as five bushels of nuts per year. Scattering trees 60 feet high produce two bushels per year. The younger trees behave like those mentioned above. Most of the nuts are of good quality and some are thin shelled and of good size. One man reports grafting on black walnut with fair success by the bark grafting method. He cuts Persian walnut cions early in March and stores them in an ice-house until the last of April or first part of May. Then he saws off the stock slanting, splits the bark, makes a four inch slanting cut on one side of the cion and slips it in and waxes the wound securely. One named variety mentioned in this section is Prœparturien.

Only a few pecans are mentioned in this section as are also a few Japan walnuts, chestnuts and filberts. The improved chestnuts have not been profitable generally, and since the various native nuts are so abundant there has not been much incentive to grow cultivated ones.

In the section south of the one just mentioned and between the Potomac River and Chesapeake Bay, there are without doubt many nut trees, but only a few have been located by this survey. The climate is mild, comparatively speaking, and the production of nuts ought to be a most tempting vocation in this section.

Doubtless the best portion of the State for the nut industry is the entire Eastern Shore, that is, all of that portion east of the Chesapeake Bay. The climate of this section is modified somewhat by the waters of Chesapeake and Delaware bays and the soil is especially adapted to fruit and nut production. Eighty-five Persian walnut trees were specially reported and others mentioned as being in the various neighborhoods. There are a good many magnificent old specimens from 50 to 80 years old, producing from one to five bushels of nuts annually. One tree 50 years old is said to have produced from three to ten bushels of nuts per year for the last 30 years. Many of these trees yield a product that is equal if not superior to "store" nuts. Nearly all of the younger trees are productive, but a few are not. These are mostly seedlings and usually bear nuts as good or even better, than those from the parent tree. Several grew from nuts grown in California. They began bearing at from five to ten years after planting. One correspondent 84 years of age reports that 50 years ago Persian walnut trees were as common as plum trees in his section of Queen Anne county, but now they are very scarce, having died from utter neglect. There was one orchard of 50 trees. The Grenoble is the only variety mentioned. This began bearing when six years old.

Strangely enough pecans are reported in larger numbers than Persian walnuts in this section, over 200 trees being mentioned. They grow luxuriantly, are not troubled with insects or diseases, and are much used for lawn trees. A few are seedlings grown from nuts obtained in New Orleans. Many of these trees bear thin shelled nuts of good quality, but usually small in size. One tremendous tree 100 feet high and 100 feet in spread of branches with trunk five feet in diameter, is said to have grown from a nut planted 107 years ago. Three other venerable companions of "Father Time" are each 100 years old, and two bear extra good nuts, they are also five feet in diameter. A third "old timer" is 83 years old. The writer measured one tree whose spread of branches is 75 feet and the trunk diameter four feet, but unfortunately the nuts are not edible. Other trees near by bearing good large nuts are 2½ feet in diameter.

One man in Talbot County has 50 seedlings 12 years old, another in Somerset County has 125 fifteen years old which are just beginning to bear choice nuts. Only a few named varieties were mentioned. One correspondent has six Stuart and six Van Deman trees 15 years old. The former began bearing at six years and the latter at 10 years of age. Another correspondent has the Pabst and Alley varieties.

In this section are a few Japan walnuts, filberts, improved hickories and improved black walnuts and an abundance of native nuts. There was one report of three almond trees in full bearing.

Nearly every correspondent from every part of the State except the extreme west, voices the opinion that the Persian walnut particularly can be profitably grown in Maryland if the trees are cared for. Many think the pecan may also be produced with profit.

Nut growing in Maryland may be briefly summarized as follows: The native black walnut, butternut, hickory, chestnut, beech, hazel and chincapin abound almost everywhere. A few of the black walnuts and hickories are of especial merit, and will be utilized as a basis for improving these nuts. Most of the state has produced excellent Persian walnuts and some pecans for more than a hundred years. Only a few named varieties of the improved sorts have thus far been tried. The improved varieties of chestnuts are not generally profitable, but may become so if the immense crop of native chestnuts is cut short as is now threatened by a disease which is causing the death of hundreds of trees from two to three feet in diameter. The Japan walnut is not much grown and is not likely to be. There is an awakening to the possibilities of nut culture, probably caused by the intensely active earnestness with which several of the Southern States are taking hold of this problem, and in a few years Maryland will rank as a nut producing state. She has the requisite soil, climate and incentive, and since satisfactory varieties are to be had, it is now only a question of launching the industry systematically and this movement has already begun.

NUTS AS FOOD.

The planting of nut trees ought to be encouraged and increased until the nuts are produced in large enough quantities to become a staple article of food instead of only a luxury. They can, to a very considerable extent, be used in a mixed diet to take the place of meat. At 20 cents per pound for walnuts and 25 cents per pound for porterhouse steak, an equal investment in each will produce about one-fifth more in weight of food material and in energy in the walnuts than in the steak. (See 1906 Year Book of the U. S. Dept. of Agr.). Pecans rank higher than walnuts in a similar comparison. For use as luxuries only, the addition of thousands of acres of productive nut orchards to our present supply would be profitable.

ACKNOWLEDGMENT.

The writer has had only a limited actual experience with nut trees, but has gained the following information on the propagation, grafting, budding, planting, etc., of nut trees from conversation and correspondence with nut growers in several states, from press reports, and from Experiment Station and Horticultural Society reports. He has drawn liberally on illustrations from the Florida Experiment Station bulletins, and the report on the California Walnut Industry, by B. M. Lelong, secretary of the California State Board of Horticulture.

The photographic copying of the illustrations in this bulletin was done by Mr. W. R. Ballard.

PROPAGATING THE *PERSIAN WALNUT.

Since Persian walnut trees of desirable varieties are scarce and expensive it is highly desirable to grow one's own trees if possible. Although this requires more care and attention than the growing of young fruit trees, it can be done successfully on the farm.

The easy though not usually the desirable way is to plant the nuts and grow seedlings for orchard trees. In case one cannot secure grafted or budded trees, but can secure nuts from grafted trees true to the variety name, this practice is allowable because it has been noticed on the Pacific Coast that in such an event about one-third of the resulting seedlings produce nuts like the parent, one-third produce nuts superior to the parent, and the other third produce nuts inferior to the parent. The inferior seedlings could be grafted or budded to the parent variety, but time is lost in doing this and it would be better practice to set grafted or budded trees.

Figure 1.—(After Hume—Florida Agrl. Expt. Sta. Bul. No. 85). Whip grafting pecans at the crown in nursery row.

Planting the nuts.—The seedlings of either Persian walnut or black walnut are used as stocks upon which to graft the Persian walnut. The nuts may either be stratified in damp sand or planted in the nursery rows in the fall, or be kept dry for spring planting. When the latter is done it is well to soak the nuts in warm water twenty-four hours just previous to planting. Nuts are stratified in a box or cold frame by putting in alternately three or four inches of earth and nuts. Keep moist in a cold place. Plant the nuts in rows four feet apart and eight inches apart in the row. Cultivate and care for the seedlings so they will grow as large as possible during the first season. Most of this growth will be in the roots.

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*This is usually called the English walnut and often the Madeira nut.

Crown-grafting the seedlings.—When the seedlings are one year old they may be crown grafted as they stand in the ground. Remove the earth and take off the top at the point where it swells in joining the root as shown in Figure 1. Either the cleft or whip method may be employed. Make cions five or six inches long of well matured wood with strong plump buds of the previous season's growth. Have cion and root about the same size if possible. For cleft grafting trim one end of the cion to a wedge shape with one side of the wedge a little thicker than the other and with the cut or scarf of *one side only* through the pith, as shown in Figures 2 and 3. A bud should be located at the upper end of the scarf cuts on the thicker outer side of the cion. Make a cleft or split in the root and place the wedge end of the cion, thick side out, tightly into the cleft, being most careful to have the light colored inner bark of the cion and root touch because this is the point where the cion and root grow together. It is well to cross the cion and root very slightly so as to be sure that the light colored or cambium layers of bark touch at some point. Wrap tightly with large soft twine and cover all cut surfaces carefully with grafting wax as shown in Figure 4. Do not cover the string with wax clear around the graft, leave part of it uncovered as shown in Figure 3 so it may decay before it chokes the growing union. Mound the earth up firmly to the top bud of the cion.

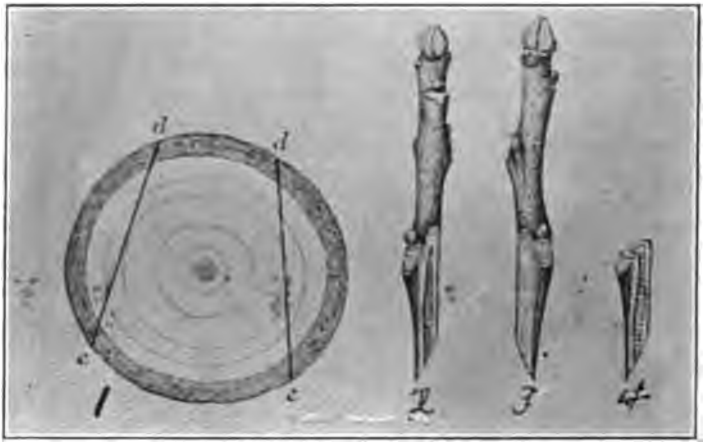

Figure 2.—(Cut taken from "Nut Culture in the United States").
Cleft Sap Grafting.
1. The lines d e show where the clefts should be made.
2. Cion ready for cleft grafting. Note scarf cut through pith.
3. Opposite side of cion shown in 2, note the scarf does not touch the pith, also note position of bud at upper end and between scarfs.
4. Shows size of pith in cion.

If the whip or tongue graft method is used the cion and root are both trimmed alike as shown in Figure 5. A long smooth cut is made across each and a second cut between the pith and bark is made parallel with the long side to form the tongue. These prepared ends are fitted tightly together so that the cambium layers of bark touch, the union is wrapped with twine and waxed, and the earth mounded around the cion exactly as in cleft grafting.

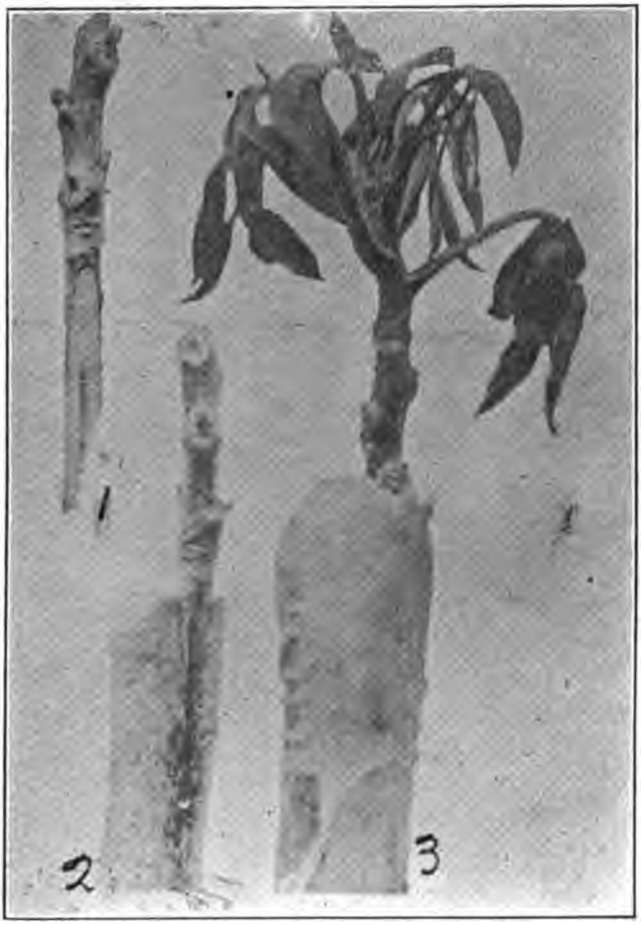

Figure 3.—(After Lelong—California Walnut Industry).
Cleft Grafting the Walnut.

1. The prepared cion.
2. Cion inserted in cleft.
3. Cion tied and waxed—three weeks growth.

In California the seedlings are sometimes dug for indoor cleft or whip grafting like that practiced with apples. (See Figure 4). This method is not likely to be successful unless the grafts are started in the greenhouse.

TOP WORKING WALNUTS.

There are many black walnut and seedling Persian walnut trees in the State which ought to be top grafted to the improved French varieties or to some extra good seedlings. The time to do this is in the spring just as growth is starting, but the cions should be taken early in spring and be kept dormant in moist sand in an ice-house or other cold place.

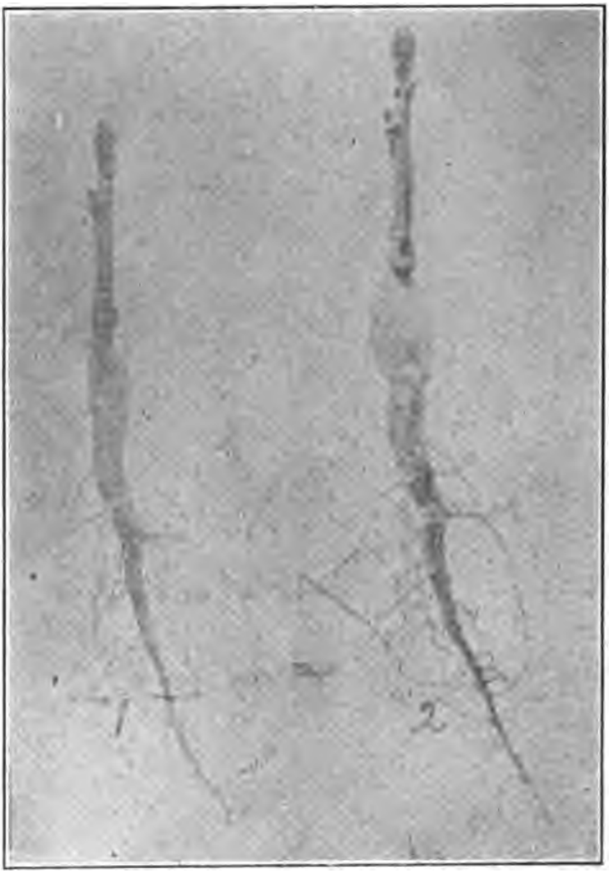

Figure 4.—(After Lelong—California Walnut Industry).
Root Grafting the Walnut.
1. Root with cion inserted, ready for waxing.
2. The same waxed and ready for planting.

Cleft sap method.—It is best to use limbs from one to two inches in diameter for grafting, but those three or four inches in diameter may be used if necessary. Figures 2 and 3 show how this may be done. Saw off the limb and trim the end smooth with a sharp knife. Split the stub with the grafting chisel *through the sap wood* as shown by the lines d e in Figure 2. *Do not make the cleft through the pith.* Trim the cions to a wedge shape, as shown in Figures 2 and 3, and as described under, "Crown grafting the seedlings." Push the cion firmly into the cleft, thick side out, slightly crossing it with the stock so the cambium layers of bark will touch. In limbs over an inch in diameter put from two to four cions, as they help to heal over the wound and the extra ones may be cut off after one year's growth. As soon as the cions are in place bind stout twine or waxed cloth around the stub to prevent the clefts from opening up and the cions from loosening, and cover every cut or split portion of bark or wood with grafting wax to prevent any drying out of the stock or cion. This is important and the wax must be examined occasionally and kept in place during the entire season. If limbs are too large or too high up for grafting, the tree may be stub pruned as shown in Figure 8. This pruning forces out new shoots which may be either budded or grafted.

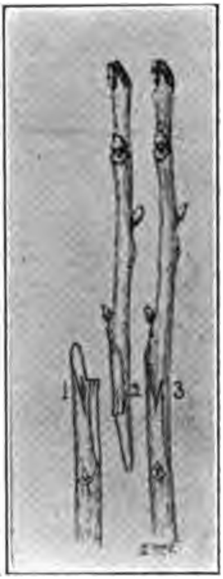

Figure 5.—(After Hume—Florida Agrl. Expt. Sta. Bul. No. 57).
Whip Grafting.
1. The stock Prepared.
2. The cion prepared.
3. The two united.

Prong grafting or prong budding.—Figure 6 illustrates this method very plainly. Saw off and smooth the end of the limb, and two inches below make the T-shaped cut as shown at 1. With a sharp thin bladed knife take off the prong beginning to cut about an inch below the prong and extending the same distance above. This will leave considerable bark and a little wood on the prong. Remove the wood and the prong will appear as at 2. Slip the prong between the lips of the T-shaped cut on 1 and it will take the position shown at 3. Now

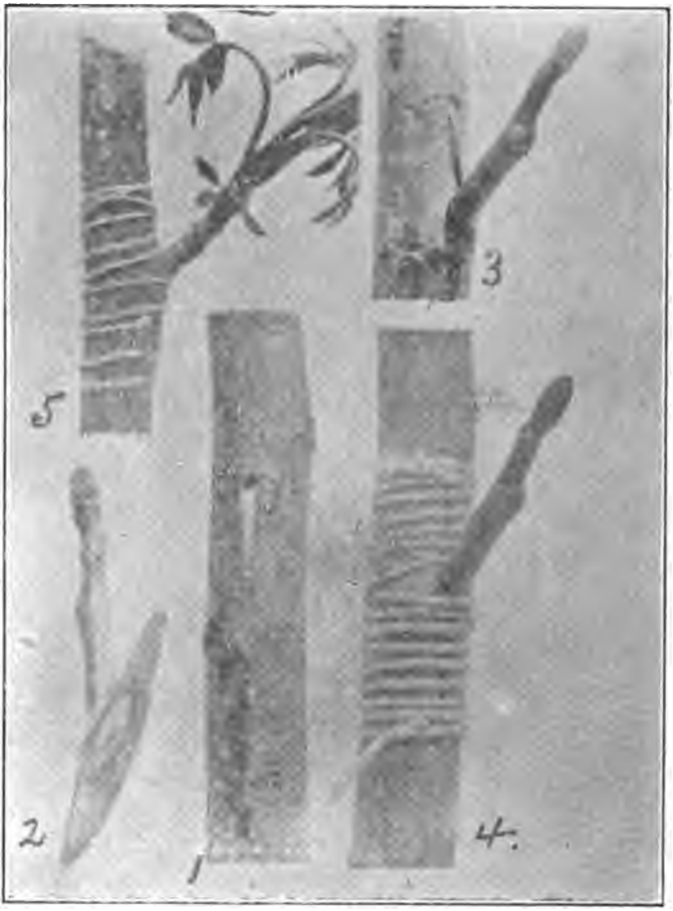

Figure 6.—(After Le'ong—California Walnut Industry).
Prong Budding the Walnut.
1. The stock cut off and T shaped incision made.
2. The prong bud prepared for placing in incision in 1.
3. The prong bud inserted.
4. The twine in position to hold prong bud in place.
5. The completed job, waxed, retied and growing.

wrap tightly with large soft twine as at 4 and cover all cut surfaces, including end of stub, carefully with grafting wax. Watch for the enlarging of the stock and if the string cuts into the bark loosen it and tie again. The prong starting into growth is shown at 5. The new growth is very tender and should be protected in some way from being broken by the wind or by birds lighting on it. It may be tied to the stub.

This operation is done in spring when growth is starting and the bark will peel. The prongs are taken from twigs grown the previous season and are usually from one to two inches long. These twigs should be secured early and kept dormant as mentioned for cions.

Annular budding.—This method of budding is the best one to use on young trees and older limbs with smooth bark. It is done in summer or fall when the bark peels readily. If done in early summer the buds are taken from cions of the previous season's growth which have been kept in moist sand in an ice-house or other cold place. The bud stick and stock ought to be about the same size so that the ring of bark will fit well. Choose a plump bud and remove it with a ring of bark an inch or more wide as shown in Figure 7. Take a similar ring of bark off the stock and slip the bud ring in its place. Wrap well with waxed cloth to protect all cut places from drying out. The buds put in during August and September remain dormant until spring. When they start growing the limbs should be cut off a few inches above the buds and a month or so later the stubs should be cut off just above the new shoot. In summer budding the buds soon begin to grow and the limbs must be cut back from time to time so as not to check the new growth.

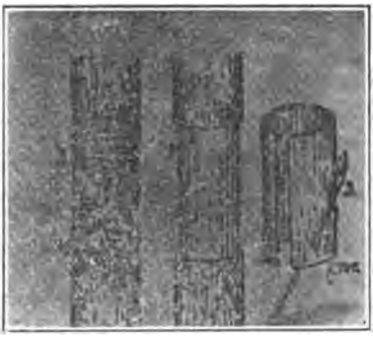

Figure 7.—(After Hume—Florida Agrl. Expt. Sta. Bul. No. 57).
Annular Budding.
1. The stock prepared for bud.
2. The bud with ring of bark.
3. The bud in place and tied.

A simple implement for cutting rings of bark of uniform width is made by tying together two budding knives with a small block of wood between them. A double cut is thus made around the bud stick, then one downward slit is made on the side opposite the bud so the ring may be peeled off easily.

PROPAGATING THE PECAN.

The pecan is propagated in about the same way mentioned for the Persian walnut. What has just been given on cleft and whip grafting of seedlings, on top working by whip grafting on small limbs and cleft sap grafting on larger limbs, and on annular budding of the Persian walnut applies also to the pecan. In stratifying the pecans for planting, more care is necessary than with walnuts. Boxes about three feet long, one and one-half feet wide and six or eight inches high are

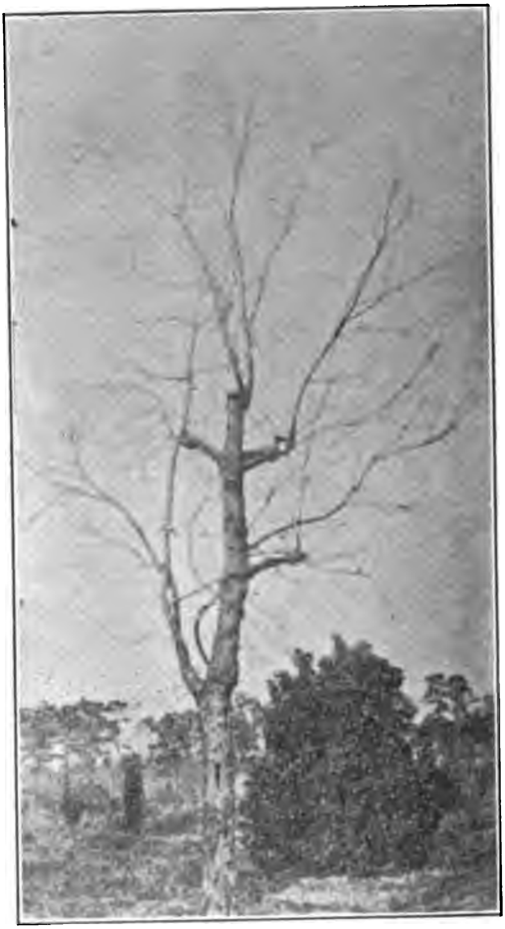

Figure 8.—(After Hume—The Pecan and Its Culture). An old Pecan Tree Topworked in the Branches.

preferred. Spread two inches of moist sand in the box, then a single layer of nuts, add sand and nuts alternately until the box is full. Cover with straw or hay to prevent drying out. The nuts usually sprout by spring. When the ground is well prepared the nuts should be planted about five inches deep in rows three or four feet apart and about eight inches apart in the row. If the little seedlings make a good growth the first season they may be crown grafted the next spring as shown in Figures 1 and 4. The smallest seedlings may be budded the following August or be crown grafted the second spring from planting the nuts.

Top working old pecan trees.—If the tree to be top grafted or top budded has too high a top, and it is desired to lower the top before doing the grafting or budding, this may be done easily by cutting off part of the top and forcing out new shoots nearer the ground, as shown in Figure 8. These new shoots may be either grafted or budded.

TOOLS AND ACCESSORIES FOR GRAFTING.

To attain success in the grafting and budding of nut trees the utmost care and accuracy of manipulation are necessary. Everything used should be especially adapted for its particular use.

Budding knife, for cutting buds and trimming cions. This should have a thin, sharp, keen-cutting blade, because ragged cutting means failure. See Figure 9.

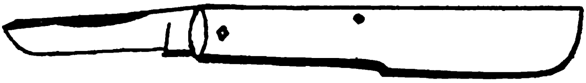

Figure 9.—Budding Knife.

Double budding knife, for taking off rings of bark in annular budding. This may be made by tying or riveting two budding knives together using a small block of wood to separate the blades from one inch to one and one-half inches.

Grafting chisel, for making clefts in cleft sap grafting. This may be purchased from seedsmen or be made by a blacksmith. The blade should be sharp and not too thick. See Figure 10.

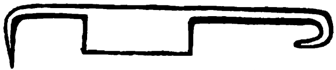

Figure 10.—Grafting Chisel.

Wooden mallet or some substitute, for driving grafting chisel into the wood.

Twine or raffia, for binding material in grafting and budding. A large soft twine is better than a smaller hard twine. Raffia may be purchased from seedsmen, it should be moistened before being used.

Grafting wax, for covering all cut surfaces in grafting or budding. Use four pounds rosin, two pounds beeswax and one pound tallow, or six pounds rosin, two pounds beeswax and one pint linseed oil. Melt the rosin and let it simmer a few minutes. Trim off hard dark colored surface of beeswax, shave up the balance and add to melted rosin and cook a few minutes. Add tallow, cook and stir a few minutes and pour all into cold water. Grease the hands and pull and work the wax until it becomes a light yellow color. Mould in rolls or balls, wrap in oiled or greased paper for future use. Make the rosin-beeswax- linseed oil wax in the same way. If the weather is cold when grafting is done the wax must be softened in warm water.

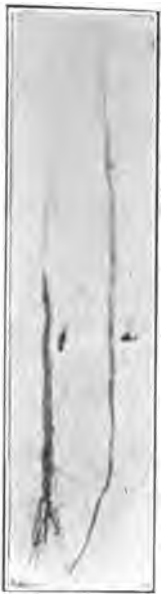

Figure 11.—(After Hume—Florida Agrl. Expt. Sta. Bul. No. 54).
1. Two year old pecan tree, tap root was cut when one year old.
2. Two year old pecan tree, tap root was never cut.

Waxed cloth and waxed twine, for binding around buds or grafts to hold them in place and exclude air. Dip old calico or cotton cloth into melted grafting wax and spread on a board or box to cool. Tear into strips when ready for use. For waxed twine use balls of No. 18 knitting cotton, dip into melted wax until saturated and hang up to cool.

Surgeons' adhesive plaster, used like waxed cloth or waxed twine. Dr. Robert T. Morris, of New York City uses this with good success, especially in budding nut trees. It excludes the air and rain admirably. It can be purchased in drug stores.

Liquid grafting wax. The writer has used liquid grafting wax successfully in grafting fruit trees and doubtless it will be satisfactory on nut trees. It has the advantage of being pleasant and clean to handle as it is kept in bottles and is spread with a brush. Use one pound of white rosin and one ounce beef tallow, melt these together and *remove from the fire;* then add slowly eight ounces of alcohol stirring constantly until smooth. Put in bottles and cork tightly.

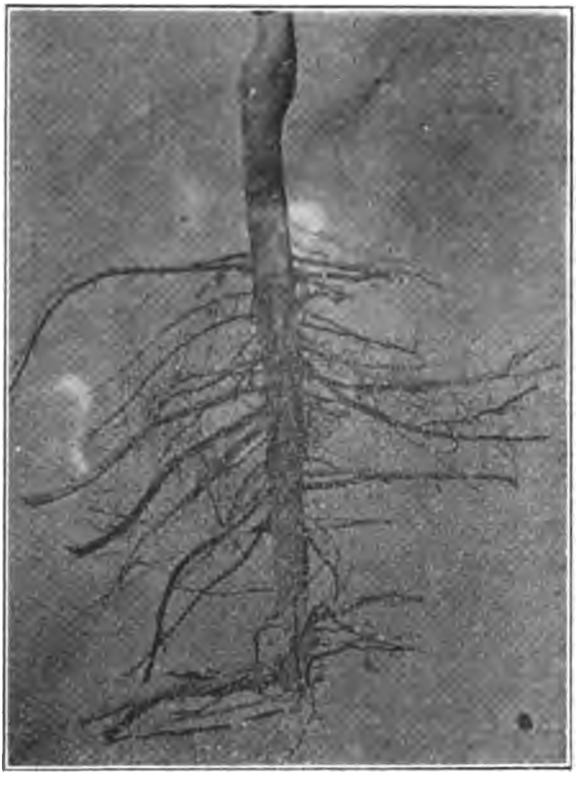

Figure 12.—(After Hume—Florida Expt. Sta. Bul. No. 85). Root system of a well grown pecan tree. The tap root was cut in the nursery when one year old.

PLANTING THE TREES.

The old idea that these nut trees will die if the tap root is cut has been exploded. It would be desirable to cut the tap roots of all yearling trees in the nursery so as to force out lateral roots and thus make a better root system. Figure 11 shows two tap roots two years old, the left one of which was trimmed off when one year old. Figure 12 shows a well branched root system resulting from pruning the tap root. Trees two or three years old so treated will transplant much more successfully than trees of the same age which have never had the tap root cut.

Preparing trees to plant. In preparing trees for planting leave from 15 to 24 inches of tap root on small trees, and from 20 to 30 inches on larger trees. Cut off all bruised or broken parts of roots, leaving smooth clean cuts. New tap roots usually develop if the tree has need of them.

The top will probably not need pruning except to remove broken or bruised limbs.

Caution. Do not allow the roots to become dried out the least bit. It is best to dip the roots in thin mud as soon as unpacked and heel in at once. When planting take out a few trees at a time and wrap the roots in wet burlap bags until planted.

Setting the tree. The hole should be large, three feet across, and deep enough to set the tree an inch or two deeper than it was in the nursery. Place the tree in position and fill in with rich surface soil, packing it firmly around all of the roots. Mulch the surface around the tree with manure to retain moisture and enrich the soil.

Orchard and lawn planting. One special object of this bulletin is to encourage orchard planting of nut trees, rather than lawn planting so as to start the industry on a large scale. However, the planting of these trees on lawns, along highways, lanes, fence rows, etc., to replace maple and other shade trees, is earnestly recommended. No more beautiful ornamental trees than these could be wished for and they are at the same time profitable.

They should be planted at least 40 feet apart along highways, lanes, etc., and 50 feet apart in orchards. At this latter distance it requires 17 trees per acre. Other orchard trees like apples, pears, or peaches may be used as fillers until the nut trees require all of the space. The fillers may be set 16⅔ feet apart in the nut tree rows and two extra rows of fillers 16⅔ feet apart may be set between each two rows of nut trees. Thus the entire ground is occupied and may be handled as mentioned under, "Cultivation and Crops."

SOIL.

The most desirable soil seems to be a good sandy loam with clay subsoil. Almost any good well drained soil not underlaid with hardpan and not in too low a situation, will doubtless be entirely satisfactory.

CULTIVATION AND CROPS.

For the best success the trees ought to be given as good care and cultivation as any peach or apple orchard receives. Such crops as tomatoes, round or sweet potatoes, sweet corn, melons, cowpeas for fodder or seed, may be grown in the orchard for perhaps ten years or until the trees are bearing fair crops. Liberal amounts of fertilizer should be used on the crops so the nut trees will not be injured or stunted. Early in August the cover crop seed should be sown. Crimson clover seed, 20 pounds per acre, ought to produce a satisfactory cover crop. This should be plowed down in spring and the ground cropped again.

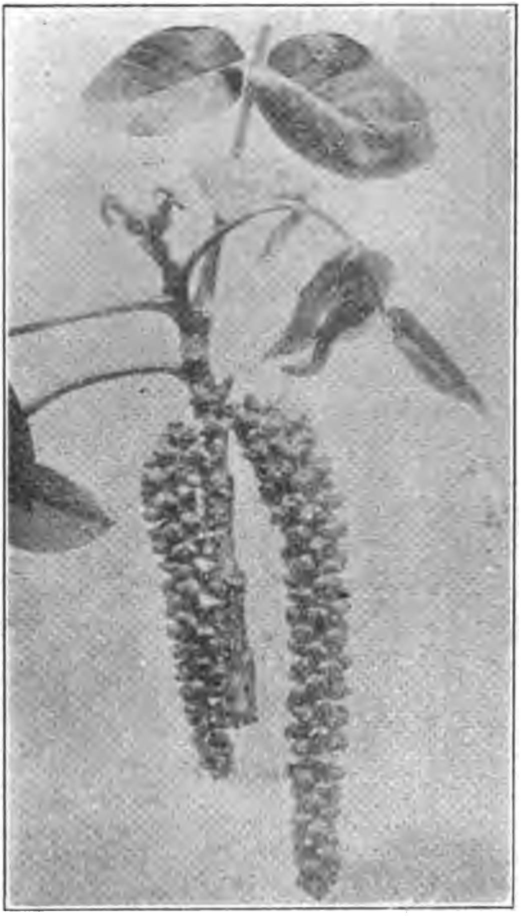

Figure 13.—(After Lelong—California Walnut Industry). Staminate catkins or male flowers below, female flowers at tip of twig. Staminate catkins are on twig one year old, female blossoms are on new growth.

WINTER PROTECTION.

It is a common experience that nut and some other trees for the first few years are tender enough to be winter injured, but after that they become hardy. For this reason it is highly desirable to wrap them in burlap, straw, corn stalks, or other material to protect from severe cold and also from the warm rays of the winter sun early in the afternoon on mild days. The sun about 2 o'clock P. M. will often warm up the south-west side of the tree enough to start a movement of sap. In two or three hours the temperature may drop to the freezing point and the thawed bark is again frozen. This freezing and thawing continues until the tender cell walls are ruptured and the bark discolors and dies. This result is commonly called sun scald and it may in time kill the tree. It is also well to mound the earth a foot high around the tree trunk.

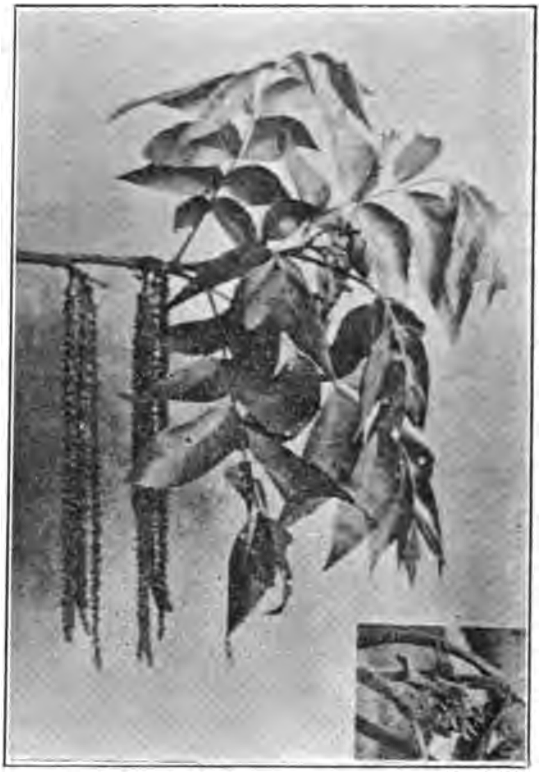

Figure 14.—(After Hume—The Pecan and Its Culture).

Catkins of male Pecan blossoms on one year old wood and female blossoms on new wood shown by arrow. Female blossoms in lower corner.

In climates where injury by severe cold is not feared it is well to at least shade the trunk on the south-west side by means of a narrow board or veneer protector.

BLOSSOMS.

The blossoms are peculiar when compared with fruit tree blossoms. The male and female blossoms are entirely distinct in appearance and position. The former are long showy catkins, coming nearly always from one year old twigs and appearing at the same time or a week or two before the inconspicuous female blossoms at the terminals of the new growth. Figure 13 shows the large male catkins of the Persian walnut on one year old wood and the female flower cluster on the new growth. Figure 14 shows similarly the male and female pecan blossoms although the latter are indistinct, but are shown alone in the lower corner of the picture.

VARIETIES OF PERSIAN WALNUTS.

From the best information the writer could obtain it seems that the varieties mentioned below will succeed in Maryland. It is necessary for trees here to be slow in starting into growth in spring and late in blooming so as to avoid injury by late frosts. The following varieties are doubtless all satisfactory in these respects. The first five are thin shelled French varieties and the descriptions of them are taken from "California Walnut Industry." They are all productive bearers.

Chaberte. Fair sized, roundish-oval; kernel extra fine quality.

Franquette. Quite large and attractive, elongate-oval; kernel full fleshed and sweet, and of a rich, nutty flavor. Blooms late in spring and is as hardy as Parisienne and Mayette Blanche.

Mayette Blanche. One of the finest dessert and market nuts grown. Especially valuable because of being so hardy and such a late bloomer. Quite large and uniform, roundish; kernel full-fleshed, sweet and nutty. It is often called Grenoble.

Parisienne. Larger and broader at apex than Mayette Blanche and equal to it in all respects.

Proeparturiens. Medium size, very sweet kernel, extra early bearer.

San Jose. This is a seedling of Mayette Blanche originated several years ago by Mr. R. Wiltz, 16 Lucretia Avenue, San Jose, California. It is considerably larger than any of the above varieties, a late bloomer, an early and prolific bearer, as hardy as its parent, and is thin shelled and of excellent quality. It is extremely promising for Maryland.

Rush. This originated with Mr. J. G. Rush, West Willow, Pa. It is hardy and one of the most promising varieties for Maryland. It is larger and rounder than Mayette Blanche and is of good quality.

Norman Pomeroy. This was originated by the late Norman Pomeroy of Lockport, New York. It is claimed to be a very late bloomer, an early and prolific bearer and entirely hardy where it originated. It is not as large as the Rush. The quality is good.

Drew. The Drew is a medium sized nut originated in Milford, Delaware. The writer obtained specimens of the nuts from Mr. David Greenawalt, Chambersburg, Pa.

Peerless Paper Shell. This was originated by Mrs. Rebecca E. Semple, 217 East Broad Street, Burlington, N. J., from a nut planted by her fifteen years ago. The nuts are extra large, with thin but rough shell; kernel large and of good quality. This is promising for Maryland. The young trees need protection in winter for three or four years.

A number of good unnamed seedlings have been located in various parts of the East, and as far as possible these will be propagated at the Experiment Station and tested in various parts of the state. Reports on these will be published in due time.

VARIETIES OF PECANS.

Varieties of pecans for Maryland cannot be recommended with as much certainty as can Persian walnuts because the pecan has not yet received much attention in localities far north of its native home. From the few efforts at pecan growing already made in the state there is reason to believe that the most hardy varieties will succeed here. The following varieties were suggested by Prof. H. Harold Hume, who has had considerable experience with pecans in the Southern States. The descriptions are abbreviated from the full descriptions of varieties by Prof. Hume in "The Pecan and Its Culture."

Curtis. Medium size, 1⅝ x ⅞ inches, ovate-conical, with pointed apex; shell thin, kernel plump; flavor sweet, rich, nutty; quality excellent.

Horlbeck. This is one of the newer varieties and no description is available.

Mantura. Large size 2 x ⅞ inches, oblong-oval, blunt pointed at base, sharp pointed at apex; shell very thin, cracking quality very good; kernel plump; flavor sweet, nutty; quality very good.

Moneymaker. Size medium, 1$\frac{5}{16}$ x 1 inches, ovate-oblong; base rounded, apex abruptly rounded, slightly wedged; shell medium thick, cracking quality very good; kernel plump; flavor sweet, good; quality very good.

Pabst. Size large, 1⅝ x ⅞ inches; oblong-cylindrical, base rounded, apex blunt, four angled, grooved; shell medium thick; cracking quality fair; kernel plump; flavor good; quality very good.

Stuart. Large to very large, 1⅞ x 1 inches; ovate-cylindrical; base rounded, tipped; apex blunt, abrupt, somewhat four angled; shell medium thick; cracking quality very good; kernel plump; flavor rich, sweet; quality very good.

Van Deman. Large to very large, 2⅛ x 1⅞ inches, oblong-cylindrical, base sloping, blunt-pointed; apex tapering, sharp pointed; shell medium thick; cracking quality fine; kernel fine grained and compact, sometimes slack at end; flavor sweet and delicate; quality very good.

CONCLUSION.

There is scarcely any good reason why people who own favorably located, well drained land without hardpan subsoil in Maryland, should not plant nut trees, especially the Persian walnut and pecan. The old argument, "I am too old to plant trees," is out of date, and any loyal citizen ought to be ashamed to hide behind such a flimsy excuse. There are comparatively few people in the State who are really too old to receive some benefit from, or to take pride in, trees of their own planting. Many of the varieties mentioned above will bear at from six to eight years from planting and at from two to four years from top grafting or top budding. These few years pass rapidly and even though the one who plants does not reap the harvest, he or she plants for future generations and erects in these trees monuments to keep his or her memory green for many scores of years.

The young and middle aged should not only plant nut trees themselves, but should encourage the children to do likewise. Every farm boy ought to have a small nut nursery and be taught to plant and care for nut trees. Nothing more creditable could be done in the schools than to interest the boys and girls in the possibilities of nut production and to celebrate Arbor Day with the planting of nut trees. The Maryland Experiment Station will attempt to furnish free of cost one or two nut trees to the first fifty schools of the State who apply for trees to plant on Arbor Day, 1908, providing the requests are sent in before definite plans have been made to use all of the trees on hand for experimental work. If any interest is shown by the schools in this subject the Experiment Station will endeavor to furnish trees free of cost to them for Arbor Day planting in 1909.

In the spring of 1907 the Experiment Station sent 74 Persian wanut trees to 16 localities in the State. This year the Station purchased nearly 1,200 trees of Persian walnuts and pecans for establishing eight or ten test orchards in different portions of the state, and for sending to individuals for testing in from 75 to 100 different localities. In this way it is hoped to determine the usefulness and range of the different varieties of Persian walnuts and pecans and to create a healthy interest and rapid growth in the nut industry. If the writer's efforts in this work are rewarded by making one hundred nut trees grow in the near future where one nut tree is growing today, he will feel well repaid for his work.

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THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 126. APRIL, 1908.

MANURING AND FERTILIZING TRUCK CROPS.

By C. P. Close and Thomas H. White.

The radical differences in the practices and opinions as to the proper use of manure and fertilizers between the growers of the staple farm crops and the growers of the truck crops, and the fact that many of these opinions are not supported by the theories frequently worked out and presented by scientists, called forth the few experiments reported upon in this bulletin.

These tests cover only a portion of the points upon which there is much debate and it is to be regretted that the facilities at hand would not permit taking up the questions on a much broader and more extensive scale; yet the results would seem to be of sufficient interest and value to warrant a report at this time.

It had been noticed that where corn land had been treated with animal manure there was invariably an increase in the crop while the same land treated with chemicals would very often "fire" the corn, or in other words the stalks would become prematurely ripe with a resulting decrease in the yield of grain. As it is the usual practice to spread stable manure on the surface and turn under at the time of plowing, it was thought perhaps something might be learned about this matter if chemical fertilizers were used in the same way.

In considering this plan of procedure it was of course understood that this manner of applying commercial fertilizers while being radical might also be wasteful. Still not necessarily so, when it is considered that the more valuable parts of animal manures become easily soluble yet they seem to be retained by the soil for a long period. For instance, manure is frequently plowed down in the fall several months before the crop is planted.

STUDIES MADE WITH REFERENCE TO TRUCK CROPS OR A TRUCK FARM ROTATION.

The tests reported upon in this bulletin were conducted on four series of plots, known as A, B, C, and D.

Series A was started in 1902.
Series B was started in 1903.
Series C was started in 1904.

Series D was started in 1899.

The following is a list of the points under discussion and upon which it was desired to get information concerning:

1—Comparison of stable manure and commercial fertilizer.

2—Comparison of plowing commercial fertilizer under, and using it as a top dressing harrowed into the soil just before plânting the crop.

3—Comparison of heavy and light applications of commercial fertilizers.

4—Comparison of heavy and light applications of stable manure.

5—Comparison of fresh and rotted stable manure.

6—Comparison of rotted manure turned and unturned while in the compost heap.

7—Comparison of commercial fertilizers derived entirely from mineral sources with those derived entirely from animal and vegetable sources.

8—Comparison of the use of stable manure and commercial fertilizers for sweet potatoes.

PLAN OF EXPERIMENT.

The plan as outlined was to use manures and commercial fertilizers in connection with green crops turned under, and to plant truck crops rather than general farm crops. Also on series B and C the fertilizers were mixed so as to compare with barn-yard manure especially in the nitrogen content. The aim was to supply the same amount of actual plant food in the form of chemical fertilizer as was found in the stable manure. Wishing to make the experiments comprehensive and useful to the reader who desires to follow the several seasons' work in detail, the series are at first discussed at length. Later the comparisons are made under their several headings in separate tables.

SERIES A, STARTED 1902.

The plots 1, 2, 3 and 4 were 21⅞ ft. x 100 ft. containing about $\frac{1}{20}$ of an acre.

Plot 1—Received the rate of 15 tons of good stable manure per acre *plowed down* in the spring.

Plot 2—Received commercial fertilizer 750 lbs. per acre at planting time.

Plot 3—Received same as plot 2, but the fertilizer was sown on and *turned under* with the sod the same as the stable manure in the spring.

Plot 4—Was the check or "nothing" plot receiving no fertilizer.

The soil was a stiff loam underlaid with clay. The land had been in timothy sod for two years. All of the plots were plowed on April 20. The first crop was late cabbage. The ground was kept mellow and clean by harrowing. On June 15 the fertilizer was applied to plot 2 and the land was prepared for cabbage.

Table I shows for each plot the kind, amount and value of fertilizing material used in 1902, the yield and value of crop and the gain in dollars by the use of the fertilizers and manure.

Table I. Shows for 1902 the Kind, Amount, Value and Application of Fertilizing Material, the Yield and Value of Cabbage Crop, and the Gain by Use of Fertilizers and Manures.

Plot number and treatment.	Kind of fertilizer.	Per cent. of plant food applied. fertilizer.	Weight of crop, pounds.	Value of crop at ½¢ per lb.	Cost of fertilizer.	Gain from fertilizer.
Plot 1. Manure plowed down April 20.	Stable manure 15 tons.	Nitrogen .4 Phos. acid .2 Potash .5	35389	$176.94	$30.00	$107.21
Plot 2. Com. fertilizer sowed on surface at planting time, June 15.	Dissolved S.C. rock, 348 lbs. Dried blood, 186 lbs. Muriate of potash, 112 lbs Nitrate of soda, 113 lbs.	Nitrogen .5 Phos. acid .7 Potash .7	33772	$168.86	$11.08	$118.05
Plot 3. Com. fertilizer plowed down April 20.	Same as plot 2.	Same as plot 2.	37976	$189.88	$11.08	$139.07
Plot 4. Check, Received no fertilizer.			7946	$ 39.73		

After the cabbage was harvested the plots were seeded to rye. On April 24, 1903 a square yard of the rye was cut and weighed green. After drying it was weighed again. The green and dry weights follow:

	Lbs. per acre green.	Lbs. per acre dry.
Plot 1	9680	1512
Plot 2	6352	1058
Plot 3	8772	1361
Plot 4	2722	454

Plot 1 received manure and plot 3 received fertilizer as in 1902, and on April 24, 1903, the green rye was turned under. The ground was kept in good condition and on June 26 the fertilizer was applied to plot 2.

Stowell's Evergreen sweet corn was planted on June 26 and made a poor stand and a poor growth on account of the wet season.

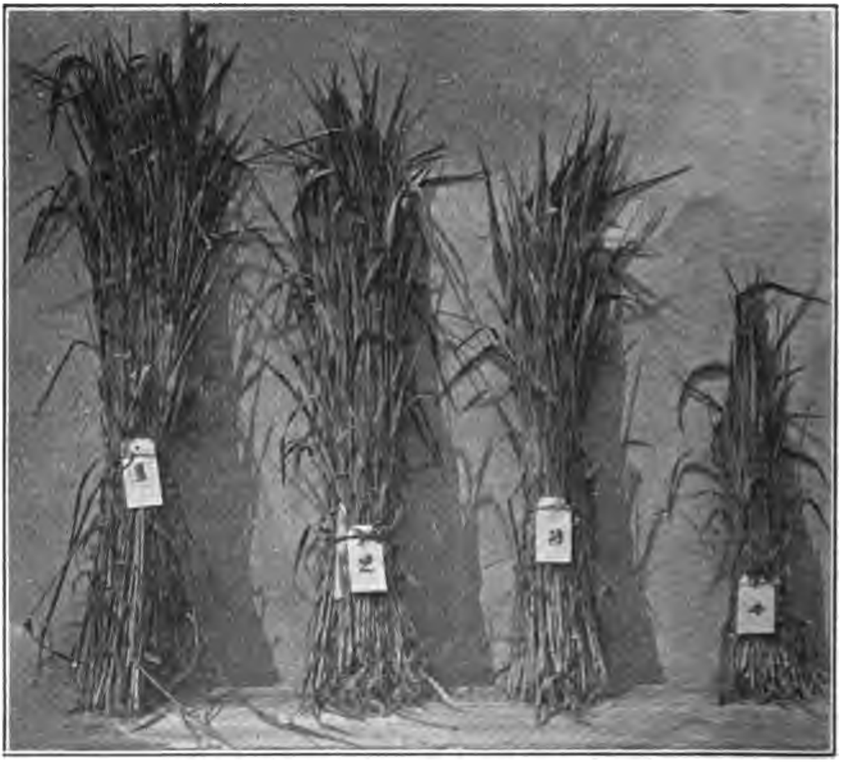
Plot 1 had about 5% of a stand with poor growth and medium sized ears.

Plot 2 had about 50% of a stand with growth and ears like plot 1.

Plot 3 had about 80% of a stand, otherwise it was like plot 1.

Plot 4 had about 80% of a stand with poor growth and no marketable ears.

It is interesting to note that the corn came up better on plot 3 which had the fertilizer plowed under in the spring and on plot 4, the check plot, than on either of the others. The stand being so irregular it was impossible to secure accurate data, therefore no other records were kept of this crop.



Rye from Plots 1, 2, 3 and 4, Series A, 1903.

Crimson clover was sown at the last working of the corn.

By May 1, 1904, the crimson clover was coming into bloom. Plot 1 had a good stand and the best clover of any of the plots. Plot 2 was not quite as good as plot 1. The stand on plot 3 was not very good, but the plants were vigorous and strong. Plot 4 was very poor in stand and growth.

On May 16, 1904, plot 3 received its usual amount of commercial fertilizer. Plot 1 which had received stable manure the two previous seasons had nothing put on this year because it was thought that there being a much larger amount of plant food in the manure than in the fertilizer, it would be a fairer comparison to leave off the manure for one season. The plots were all plowed on May 16 turning under the crimson clover.

On June 17, plot 2 received its dressing of commercial fertilizer as in the years previous and the ground was prepared for late cabbage.

The yields for 1904 and the increase in value of the fertilized plots over the check plot are as follows:

Plot.	lbs.	Value at ½¢ lb.	Value of fertilizer.	Gain over check.
1	9280	$46.40	.....	$35.50
2	7780	38.90	$11.08	16.92
3	8540	42.70	11.08	20.82
4	2180	10.90	.....	.....

Check Plot Series A, Showing the Poor Grade of the Cabbage.

The cabbage was harvested so late that the cover crop seed could not be put in.

On April 3, 1905, plot 1 received manure and plot 3 fertilizer as usual.

The plots were all plowed on April 18 and the fertilizer was applied to plot 2. Maine grown Early Rose seed potatoes cut to one eye were planted at once.

The weather was very dry, and the stand of vines was very poor.

The potatoes were dug September 7 and the yield was as follows calculated per acre:

Plot.	1st grade lbs.	2nd grade lbs.	Value.	Value of fertilizer.	Gain over check plot.
1	3820	1080	$40.90	$30.00	$7.60
2	2200	920	24.31	11·08	9.93
3	2240	700	24.15	11.08	9.77
4	260	280	3·30	.....	....

The first grade was valued at 60 cents per bushel and the second grade at 15 cents per bushel.

On September 16, 1905, Alsike clover was sown on all of the plots. This was mostly winter killed and on April 7, 1906, the ground was disc harrowed and again seeded with a mixture of Alsike and red clover. A good stand was secured and late in the summer this was cut and left on the ground.

On June 28, 1907, the clover was cut and cured for hay. The yields and value per acre of the plots follow, calculating hay at $15.00 per ton:

Plot.	lbs.	Value.	Gain over check plot.
1	6800	$51·00	$42.00
2	4000	30.00	21.00
3	3800	28.50	19.50
4	1200	9.00	.....

After removing the hay, plots 1 and 3 received the manure and fertilizer as in previous seasons and the plots were all plowed.

On July 8, plot 3 received its portion of fertilizer which was harrowed in. The plots were then planted to cabbage and the crop was harvested on October 10. The yields, value of crop and fertilizer and gain per acre over check plots follow:

Plot.	lbs.	Value of crop.	Value of fertilizer.	Gain over check plot.
1	19360	$96.80	$30.00	$35.34
2	24200	121.00	11.08	78.46
3	28092	140.46	11·08	97.92
4	6292	31.46	.....	.....

Table II is a summary of the results of the five years' work in series A, and shows the total amount and value of the manure and fertilizer applied to the plots, the total value of the crops on the different plots and the gain of the fertilizer plots over the check plot. All figures are given at the acre rates. The commercial fertilizer plots gave greater gains than the manure, especially the one where the fertilizer was plowed down in the spring.

Table II. Shows Total Amounts and Value of Manure and Fertilizer per Acre Applied to Series A in the Five Years and Total Value of Crops and Gain per Acre for Fertilizer Over the Check Plot.

Plot Number and treatment.	Total amount of fertilizer applied per acre.	Value of Fertilizer per acre.	Value of all crops per acre.	Total gain by use of fertlizers.
Plot 1. **Stable manure plowed down.**	**45 tons.**	**$90.00**	**$412.04**	**$227.65**
Plot 2. **Commercial fertilizer sowed on surface at planting time.**	**Dissolved S. C. rock, 1392 lbs.** **Dried blood 744 lbs.** **Muriate potash, 448 lbs.** **Nitrate of soda, 452 lbs.**	**$44.32**	**$383.07**	**$244.36**
Plot 3. **Commercial fertilizer plowed down.**	**Same as plot 2.**	**$44.32**	**$425.69**	**$287.08**
Plot 4. **Check,** **Received no fertilizer.**			**$ 94.39**	

SERIES B.

The second series or series B was laid off in the spring of 1903 and was the outcome of the fact that a comparison of the plots on series A could scarcely be fair on account of there being no relation either between the amounts or the value of the plant food in the ingredients supplied to the several plots. Series B was upon the same kind of land as series A and had been in sod the same length of time. On account of the small amount of this land of nearly uniform character the nine plots contained only $\frac{1}{40}$ of an acre each. Plot 1 received 15 tons stable manure per acre plowed down in the spring. Plot 2, check, received no fertilizer. Plot 3 received commercial fertilizer to approximate in actual plant food the amounts in the stable manure applied to plot 1. This was plowed down in the spring. Plot 4 received the same amount of fertilizer as plot 3 only it was applied and harrowed in after the ground was prepared for planting. Plot 5, check, received no fertilizer. Plot 6 received 750 pounds of commercial fertilizer plowed down in the spring. Plot 7 received the same as plot 6, but it was applied and harrowed in after the ground was prepared for planting. Plot 8 received six tons of stable manure per acre plowed down in the spring. This would supply about the same amount of plant food per acre, except in phosphoric acid, as is supplied by the 750 lbs. of fertilizer in plots 6 and 7. Plot 9, check, received no fertilizer.

This series of plots contained a strip of gravel and because of the probability of variation in character three plots were used as checks. The manure and fertilizer to be plowed down were applied and the plots were all plowed on April 23. They were occasionally harrowed until July 10, when plots 4 and 7 were top dressed with commercial fertilizer. On July 27, Premium Flat Dutch cabbage was planted. This crop was harvested November 7 and the results per acre are given in table III which also shows the amounts and value of manure and fertilizer applied, the yield and value of the crop at one-half cent per pound and the gain or loss on the fertilized plots compared with the check plots.

Cabbage on Check Plot Series B, 1907.
(Part of plot 4 in upper left hand corner).

Table III. Records of Series B, 1903—Cabbage. Shows per Acre the Amount and Cost of Manure and Fertilizer Applied, the Yield and Value of the Crop and the Gain or Loss of Fertilized Plots Compared with Check Plots.

Plot number and treatment.	Amount of Fertilizer.	Yield in pounds.	Value of crop.	Value of fertilizer used.	Gain for fertilizers.
1 Stable manure plowed down April 23.	15 tons per acre.	16,320	$81.60	$30.00	9.20
2 Check, received no fertilizer.		11,800	59.00		
3 Commercial fertilizer plowed down April 23	Dis. S. C. rock, 600 lbs. Dried blood, 1000 lbs. Mur. of potash, 250 lbs. Nitrate of soda, 300 lbs.	22,960	114.80	39.25	33.15
4 Same as 3, sowed on surface at planting time.	Same as 3.	22,400	112.00	39 25	30.35
5 Check, received no fertilizer.		5160	25.80		
6 Commercial fertilizer plowed down.	Dis. S. C. rock, 346 lbs. Dried blood, 186 lbs. Muriate potash, 112 lbs. Nitrate of soda, 112 lbs.	15,920	79.60	11.08	38.12
7 Same as 6 sowed on surface at planting time.	Same as 6.	14,120	70.60	11.08	29.12
8 Stable manure plowed down.	6 tons per acre.	14,840	74.20	12.00	31.80
9 Check, received no fertilizer.		7000	35.00		

The gain for each fertilized plot was computed by adding together the value of crop on the two check plots nearest the fertilized plot, dividing by two and increasing this sum by the cost of fertilizer and subtracting this amount from the value of crop from fertilized plot. Plots 1, 3 and 4 were compared with the average of 2 and 5, and plots 6, 7 and 8 with the average of 5 and 9.

The crop of 1903 was harvested so very late that the land was allowed to lay bare during the winter. On March 28, 1904, the manure and fertilizers were applied on the several plots which were to have fertilizers plowed under and all the plots were plowed. On April 5, after harrowing, the remaining plots received their dressings of fertilizer, and the ground was prepared for potatoes. Furrows three inches deep were laid off 2½ feet apart and Maryland grown second crop Early Rose potatoes cut to two eyes were planted 14 inches apart.

Table IV. shows the yield of first and second grade potatoes, the value of the crop at 60 cents per bushel for first grade and 15 cents per bushel for second grade, the value of fertilizer used on the different plots and the gain in value of products from fertilized plots over the check plots.

Table IV. Shows Yield of Potatoes in 1904 in Series B, Value of Crop, Value of Fertilizers used and Gain of Fertilized Plots over Check Plots.

Plot.	1st grade lbs.	2nd grade lbs.	Value of crop.	Value of fertilizer used.	Gain from fertilizers.
1	11680	2480	$123.00	$30.00	$50.65
2	4960	2680	56.30	.....	....
3	13600	3360	144.40	39.25	62.80
4	11840	3400	126.90	39.25	45.30
5	2040	3200	28.40	.....	.....
6	7040	3320	78.70	11.08	47.22
7	7040	2360	76.30	11.08	44.82
8	7040	3000	77.90	12.00	45.50
9	600	2560	12.40	.....	.....

The poor showing on plot 9 was due to water soaked soil, this being the lowest plot.

Crimson clover was sown after the potatoes were harvested.

By May 16, 1905, the crimson clover had made such a rank growth as to make it very difficult to properly apply and plow down manure and fertilizer. For this reason the clover was plowed under. The clover apparently decayed rapidly and the manure and fertilizers were applied to the plots to be plowed down on June 26, and all of the plots were plowed again. After several harrowings the plots 4 and 7 were top dressed with fertilizer and Autumn King cabbage was planted on July 7. This crop was harvested on November 7 and the results per acre are given in table V, which shows the yield, value of crop, value of manure and fertilizer used and the gain or loss of the fertilized plots over the check plots. The crop was valued at one-half cent per pound.

Table V. Shows the Yield per Acre of Cabbage in 1905, Series B, the Value of Manure and Fertilizer used and the Gain or Loss of the Fertilized Plots over the Check Plots.

Plot.	Yield in lbs.	Value of crop.	Value of fertilizer.	Gain for fertilizers.	Loss for fertilizers.
1	7760	$38.80	$30.00	.....	$8.80
2	3680	18.40	.....	.....	....
3	9880	49.40	39.25	.....	7.45
4	9440	47.20	39.25	.....	9.65
5	3360	16.80	.....	.....	....
6	6400	32.00	11.08	7.62	....
7	8080	40.40	11.08	16.02	....
8	9080	45.40	12.00	20.10	....
9	1960	9.80	.....	.....	....

Cabbage on Plot 4, Series B, 1907.

The plots were again left bare through the winter, and wishing to note the residual effect of the manure and commercial fertilizer, neither was applied in 1906. All plots were plowed April 6 and planted to Green Mountain potatoes. The season was very wet and the crop harvested was very poor on account of so many tubers decaying. Table VI gives the yield per acre of merchantable and unmerchantable crop, the value of the merchantable portion at 60 cents per bushel for first grade and 15 cents per bushel for second grade, the value of the crop and the gain of fertilized plots over check plots.

Table VI, Series B, 1906. Shows Yield per Acre of Merchantable and Unmerchantable Potatoes, the Value of Crop and the Gain of Fertilized Plots over Check Plots.

Plot.	Merchantable lbs.	Unmerchantable lbs.	Value of crop.	Gain for Fertilizer.
1	9520	1440	$108.80	$86.60
2	2920	680	30.90	.....
3	2600	800	28.00	5.80
4	3760	640	39.20	17.00
5	1160	760	13.50	.....
6	1320	440	14.30	4.45
7	1160	400	12.60	2.75
8	1200	320	12.80	2.95
9	560	240	6.20	.....

This crop was practically a failure. The heavy rains in August were no doubt responsible for the results. Plot 1 had much less rot than any of the others.

Rye was sown after the potatoes were dug in 1906.

About the third week in April, 1907, one square yard of rye in each plot was cut, measured and weighed, with the following results calculated per acre.

Plots.	Weight lbs.	Height: feet.	inches.
1	14520	2	6
2	12100	2	3
3	14520	2	6
4	15125	2	6
5	7260	1	6
6	10890	1	9
7	11505	1	10
8	10285	1	10
9	4840	1	6

On May 2, 1907, the manure and fertilizer to be plowed under were applied and all the plots were plowed turning under the rye. On July 8 the fertilizer was applied to plots 4 and 7 and the ground was prepared for planting. On July 10 all plots were planted with Landreth's Large Late Flat Dutch cabbage. The growing season, while being very moist and rainy, was free from heavy floods of rain. A good crop resulted and was harvested on October 10. Table VII shows per acre the yield and value of the crop at one-half cent per pound, the value of the fertilizer used and the gain of the fertilized plots over the check plots.

Table VII, Series B. Shows the Yield of Cabbage per Acre, the Value of Crop, the Value of Fertilizer used and the Increased Yield of Fertilized Plots over Check Plots.

No.	Yield lbs.	Value of crop.	Value of Fertilizer used.	Gain for Fertilizer.
1	31640	$158.20	$30.00	$61.70
2	16800	84.00	.....	.....
3	33040	165.20	39.25	59.45
4	31136	155.68	39.25	49.93
5	9800	49.00	.....	.....
6	23968	119.84	11.08	56.96
7	23520	117.60	11.08	54.72
8	19040	95.20	12.00	31.40
9	10920	54.60	.....	.....

The result of series B for the five years 1903-4-5-6-7 are assembled and shown in table VIII. The total value per acre of the five crops harvested, the total value of the manure and fertilizer used and the total gain of the fertilized plots over the check plots are given.

Table VIII, Series B, 1903-4-5-6-7. Shows Total Value per Acre of the Five Crops from Each Plot, Total Value of Manure and Fertilizer Used and the Gain for the Fertilized Plots.

No.	Value of five crops.	Value of fertilizer.	Gain for fertilized plots.
1	$510.40	$120.00	$199.35
2	248.60	......	......
3	501.80	157.00	153.75
4	480.98	157.00	132.93
5	133.50	......	......
6	324.44	44.32	154.37
7	317.50	44.32	147.43
8	305.50	48.00	131.75
9	118.00	.....	......

SERIES C.

Series C was begun in 1904. The object of this series was to test stable manure with commercial fertilizers both in the form of chemicals like dissolved South Carolina rock, nitrate of soda and muriate of potash and in such waste animal products as raw bone, dried blood, etc. Some truckers believed that animal refuse was superior to chemicals as fertilizers.

Three stable manure plots were included to demonstrate the most economical method for the truckers to follow with manure purchased and hauled from the city.

Land of the same character as series A and B was selected for this work. The ground had been planted several years before to apple trees, had been cultivated and for three or four seasons had been enriched by plowing under crimson clover. Two years previous to the commencement of the present experiment the apple trees were removed and field corn was planted. The next season stable manure was applied and sweet corn planted.

Nine plots of one-fortieth of an acre were in this series and were treated as follows, all amounts of manure and fertilizers being stated at the per acre rate.

Plot 1—20 tons of stable manure fresh from the horse barn spread evenly over the plot in the winter.

Plot 2—20 tons of the same manure at the same time thrown into a pile and turned occasionally so as not to fire fang.

Plot 3—20 tons of stable manure at the same time thrown into a pile but not disturbed until time to plow in the spring.

Plot 4—Check, no fertilizer.

Plot 5—Chemical fertilizers to equal the amount of plant food in the 20 tons of manure; 880 pounds dissolved South Carolina rock, 480 pounds muriate of potash, 1280 pounds nitrate of soda, plowed under in the spring.

Plot 6—Same as plot 5, but the fertilizers were spread on the surface and harrowed in just before the crops were planted.

Plot 7—Animal refuse fertilizers equal in amount of plant food to that used in the manure and chemical fertilizer plots. This was plowed under in the spring; raw bone 600 pounds, dried blood 2000 pounds, wood ashes 4000 pounds.

Plot 8—Received the same fertilizers as 7 but they were spread on the surface the same as on plot 6 and harrowed in.

Plot 9—Check, no fertilizer.

The manure was hauled to the plots on February 11, 1904, and was spread over plot 1 on that date.

The piles of manure placed on plots 2 and 3 at that time were spread on April 14. Plots 5 and 7 were dressed with fertilizers on April 14 and all of the plots were plowed. On May 3 the fertilizers were spread over plots 6 and 8 and harrowed in.

One-half of each plot was at once planted to peas, onions, lettuce, tomatoes and sweet corn. There was a poor irregular stand of these crops and no results were obtained except that the fertilized plots did a little better than the checks.

On July 14 the other half of each plot was plowed and planted to McCormick potatoes. The potatoes did well and were dug October 31 with the results per acre shown in table IX. The first grade potatoes are valued at 60 cents per bushel and the second grade at 15 cents per bushel.

Table IX, Series C, 1904. Shows Amount and Value per Acre of Manure and Fertilizer Used, the Yield of First and Second Grade Potatoes and Value of Same, and the Loss for Fertilized Plots over Check Plots.

	Yield first grade.	Yield second grade.	Value of crop.	Value of Fertilizer.	Loss for Fert'z'r
Plot 1. 20 tons per acre manure spread in winter.	5520	1840	$59.80	$40.00	$50.20
Plot 2. 20 tons manure piled and turned.	7200	1760	$76.40	$40.00	$33.60
Plot 3. 20 tons manure piled, not turned.	7360	1520	$77.40	$40.00	$32.60
Plot 4. Nothing.	6560	1760	$70.00	.....	.....
Plot 5. Dissolved S. C. rock, 880 lbs. Muriate of potash, 480 lbs. Nitrate of soda, 1280 lbs. Plowed under.	6080	1360	$64.20	$44.00	$49.80
Plot 6. Same as 5, sowed on the surface.	6160	1680	$65.80	$44.00	$45.20
Plot 7. Raw bone, 600 lbs. Dried blood, 2000 lbs. Wood ashes, 4000 lbs. Plowed under.	6840	1520	$72.20	$72.00	$66.50
Plot 8. Same as 7, sowed on the surface.	4880	1520	$52.60	$72.00	$86.60
Plot 9. Nothing.	6320	1600	$67.20	.....	.....

In 1905 the manure was hauled to the plots on January 1. On April 3 the manure piles were spread on plots 2 and 3 and the fertilizers on plots 5 and 7 and all of the plots were plowed. On April 18, the fertilizers were broadcasted over plots 6 and 8 and after harrowing it in all plots were planted to "Best Early" garden peas. These were harvested as they matured.

Table X shows per acre the yield and value of peas, the value of the manure and fertilizer used and the loss per acre on the fertilized plots.

Table X, Series C, 1905. Shows per Acre the Yield and Value of Peas, the Value of Manure and Fertilizer used and the Loss of Fertilized Plots Compared with Check Plots.

No.	Yield in bushels.	Value at $1.00 per bu.	Value of fertilizers.	Loss for fertilizer.
1	40.8	$40.80	$40.00	$30.90
2	43.6	43.60	40.00	28.10
3	34.5	34.50	40.00	37.20
4	31.7	31.70	.....	.....
5	26.4	26.40	44.00	49.30
6	22.5	22.50	44.00	53.20
7	19.3	19.30	72.00	76.50
8	29.7	29.70	72.00	66.10
9	23.8	23.80	.....	.....

After the peas were all off the plots were plowed and on July 8 were planted with McCormick potatoes. Table XI gives the yield per acre of first grade and second grade potatoes and the value of the crop at 60 cents per bushel for first grade and 15 cents for second grade, and the gain in money value of the fertilized plots over the check plots.

Table XI, Series C, 1905. Shows Yield per Acre of First Grade and Second Grade Potatoes, the Value of the Crop and the Gain of Fertilized Plots.

Plot.	Yield in first grade.	Pounds second grade.	Value of crop.	Gain for fertilized plots.
1	13720	1480	$140.90	$39.90
2	11800	1000	120.50	9.50
3	11160	1020	114.15	3.15
4	11000	400	111.00	.....
5	11280	760	114.70	3.70
6	11680	720	118.60	7.60
7	11400	720	115.80	10.50
8	12000	1080	122.70	17.40
9	10240	1160	105.30	.....

These plots having had such a large amount of manure and fertilizer applied in 1904 and 1905, none was added in 1906. The plots were all plowed in April, 1906, and planted with Paragon tomatoes. Table XII gives the yield per acre, the value of crop at one-half cent per pound, and the gain for the fertilized plots.

Table XII, Series C, 1906. Shows Yield of Tomatoes per Acre, Value of Crop and Gain for Fertilized Plots.

Plot.	Yield in Pounds.	Value of Crop.	Gain for Fertilized Plots.
1	9380	$46.90	$ 6.65
2	13900	69.50	29.15
3	14720	73.60	33.25
4	8070	40.35	.....
5	13600	68.00	27.65
6	16600	83.00	42.65
7	14180	70.90	35.60
8	14340	71.70	36.40
9	7060	35.30	.....

In 1907 manure was again applied at the same rate per acre and under the same conditions as in 1904. On May 17 the commercial fertilizers were applied to the plots 5 and 7 and all of the plots were plowed. A change was made in substituting the carbonate of potash for wood ashes in plot 7.

Plots 6 and 8 were top-dressed with fertilizer on July 9 and after being harrowed all of the plots were planted to Perfection Savoy cabbage. The cabbage was harvested on October 29.

Table XIII gives the yield per acre and value of the crops at one-half cent per pound, the cost of the manure or commercial fertilizer and the gain or loss of the fertilized plots.

Table XIII, Series C, 1907, Shows Yield and Value of Cabbage per Acre, Value of Fertilizer used and Gain or Loss of Fertilized Plots.

Plot.	Yield of Crop.	Value of Crop.	Value of Fertilizer.	Gain of Fertilized Plots.	Loss of Fertilized Plots.
1	30520	$152.60	$40.00	.....	$1.40
2	38320	191.60	40.00	37.60	....
3	38000	190.00	40.00	36.00	....
4	22800	114.00	.....	.....	....
5	39920	199.60	44.00	41.60	....
6	39480	197.40	44.00	39.40	....
7	38400	192.00	72.00	25.00	....
8	36720	183.60	72.00	16.60	....
9	19000	95.00	.....	.....	....

The results of the five crops grown in the four years 1904 to 1907 inclusive, are shown in table XIV. In this table are given the total value of all of the crops grown on each plot, computed per acre, the total cost of manure or fertilizer and the total gain or loss per acre from the use of manure or fertilizer. The figures show that it is not profitable to use such large amounts of fertilizing materials.

Table XIV, Series C, 1904 to 1907. Shows Total Value per Acre of Five Crops, Total Value of Manure and Fertilizer used and Total Gain or Loss of the Fertilized Plots.

Plot.	Value of Five Crops.	Value of Fertilizers.	Gain of Fertilized plots.	Loss of Fertil'd plots.
1	$441.00	$120.00	.....	$35.95
2	501.60	120.00	$14.55	.....
3	489.65	120.00	2.60	.....
4	367.05	......	.....	.....
5	472.90	132.00	.....	26.15
6	487.30	132.00	.....	8.77
7	470.20	216.00	.....	71.90
8	460.30	216.00	.....	82.30
9	326.60	.....	.....	.....

SERIES D.

Series D, started in 1902, is a comparison of commercial fertilizer and manure on sweet potatoes.

After some preliminary work from 1899 to 1902 inclusive, which seemed to indicate that just as good results could be obtained by using chemical fertilizers as by using barn-yard manure in the production of sweet potatoes, Series D was started.

The plan was to have three plots and to treat one with stable manure, one with commercial fertilizer and the other to be untreated for a check plot.

That the cumulative effects of the manure and fertilizer might be noticed the sweet potato was to be the crop planted year after year without a change, and as its effect upon the soil was and is still an interesting question it was thought that this might prove of value.

The original plots of $\frac{1}{20}$ of an acre each selected for this experiment, were a light yellow loam with a yellow clay subsoil. These plots were quite fertile having been heavily manured for sweet potatoes and other truck crops for several seasons. In 1902, unavoidable circumstances made necessary a change in the location and the work was moved a short distance to the present plots of the same size and character of soil as the original plots. These new plots were not as fertile as the old ones because no stable manure had been applied for several years. For a number of years previous to 1901 fruit trees occupied this land.

A careful study should be made of the tabulated data following as the amounts of manure and formulas of the fertilizers were changed whenever such change seemed warranted in order to secure best results. No attempt was made in series D, as in Series A, B and C, to use commercial fertilizer in such amounts that its analysis would be the same as that of manure. The aim was to supply plenty of potash and this in the form of sulphate which is always recommended for sweet potatoes.

Table XV shows the amounts of manure and commercial fertilizer per acre used each season and the per cent. of nitrogen, phosphoric acid and potash they contained; the yield of primes, seconds and culls per acre and the value of the crop at 50 cents per bushel of 55 pounds for primes, 25 cents for seconds and 10 cents for culls; the value per acre of the manure and fertilizer and the gain or loss per acre of the fertilized plots.

Table XV, Series D, 1899 to 1907. Shows per Acre Amount and Analysis of Manure and Fertilizer Used, the Yields of Primes, Seconds and Culls and Value of Crop, and the Gain or Loss of Fertilized Plots Compared with Check Plot.

			AVAILABLE				YIELD					
Plot	Season	Manure or Fertilizer	Nitrogen Per Ct.	Potash Per Ct.	Phos. Acid Per Ct.	Value of Fertilizer	Primes Bushels	Seconds Bushels.	Culls Bushels.	Value of Crop. $	Gain for Fertilizer. $	Loss for Fertilizer. $
1	1899	Manure, 15 tons	4-5	5-6	2-3	$30.00	200.5	61.4	56.5	121.25	30.60	
2	"	Check					77.8	71.5	38.8	60.65		
3	"	Dis. S. C. rock, 225 lbs			8-9							
		Dried fish, 225 lbs	2-3									
		Sulfate of potash, 150 lbs.		12-13		8.80	219.5	63.2	54.7	131.02	62.57	
1	1900	Manure, 15 tons	4-5	5-6	2-3	30.00	131.0	18.1	15.1	71.53	1.92	
2	"	Check					72.6	6.0	18.1	39.61		
3	"	Dis. S. C. rock, 255 lbs			8-9							
		Dried fish, 225 lbs	2-3									
		Sulfate of potash, 120 lbs.		10-11		18.00	100.0	18.1	15.1	56.03	8.42	
1	1901	Manure, 20 tons	4-5	5-6	2-3	40.00	130.0	2.13	43.3	74.65	9.19	
2	"	Check					44.4	8.1	12.4	25.46		
3	"	Dis. S. C. rock, 240 lbs			8-9							
		Dried fish, 240 lbs.	2-3									
		Sulfate of potash, 120 lbs.		10-11		8.10	105.4	17.3	42.3	61.25	27.69	
1	1902	Manure, 15 tons	4-5	5-6	2-3	30.00	190.0	46.2	30.0	109.55	4.14	
2	"	Check					126.2	36.4	32.1	75.41		
3	"	Dis. S. C. rock, 330 lbs			7-8							
		Dried blood, 150 lbs	2-3									
		Sulfate of potash, 120 lbs.		10-11		7.62	129.4	28.2	28.4	74.39		8.64
1	1903	Manure, 10 tons	4-5	5-6	2-3	20.00	116.0	26.4	19.1	66.51	10.26	
2	"	Check					54.2	27.2	23.5	36.25		
3	"	Dis. S. C. rock, 240 lbs			6-7							
		Dried fish, 240 lbs	2-3									
		Sulfate of potash, 120 lbs.		10-11		6.90	91.3	18.3	14.1	51.63	8.48	
1	1904	Manure, 10 tons	4-5	5-6	2-3	20.00	103.0	18.1	18.2	57.84		3.12
2	"	Check					66.0	24.2	19.1	40.90		
3	"	Dried fish, 360 lbs			7-8							
		Nitrate of soda, 120 lbs	7-8									
		Sulfate of potash, 120 lbs.		10-11		9.90	91.0	18.3	14.1	51.48	62.0	
1	1905	Manure, 5 tons	4-5	5-6	2-3	10.00	109.0	30.2	20.1	64.05	28.65	
2	"	Check					40.0	14.0	19.0	25.40		
3	"	Dried fish, 495 lbs			9-10							
		Nitrate of soda, 35 lbs	6-7									
		Sulfate of potash, 70 lbs		5-6		8.55	92.0	29.1	20.2	55.29	11.34	
1	1906	Manure, 5 tons	4-5	5-6	2-3	10.00	115.0	55-2	31.4	74.44	28.69	
2	"	Check					34.0	62.0	32.5	35.75		
3	"	Dried fish, 360 lbs			7-8							
		Nitrate of soda, 120 lbs	7-8									
		Sulfate of potash, 120 lbs.		10-11		9.90	84.0	45.2	31.3	56.43	10.78	
1	1907	Manure, 6½ tons	4-5	5-6	2-3	13.00	74.0	12.2	18.4	41.89	5.35	
2	"	Check					36.0	15.3	17.2	23.54		
3	"	Dis. S. C. rock, 400 lbs			9-10							
		Nitrate of soda, 320 lbs	8-9									
		Sulfate of potash 180 lbs		14-15		13.25	53.0	16.0	16.2	32.10		4.67

For the first three years the results were clearly in favor of the commercial fertilizer, but after moving the experiment to the other plots this is not the case. These results would, however, tend to strengthen the opinion expressed before that a combination of stable manure and commercial fertilizers would in all probability be the best. It is clear, moreover, that the smaller quantity (5 tons per acre) of stable manure produced almost as large a crop and gave much greater profits than larger applications of manure. While it does look as though the yield is steadily decreasing, this may not really be the case, because the plots are in a rather low situation where the plants have to be set late in the spring and the crops harvested early in fall on account of frost, and the last three seasons have been especially unfavorable in this respect.

Diseases do not appear to have increased from continuous planting of the crop on the same land, in fact, the last crop was almost free from any disease.

DISCUSSION OF RESULTS.

In order to determine from all of the tables thus far given the comparisons of manure vs. commercial fertilizer, and commercial fertilizer plowed under, vs. top dressing with it after the ground is plowed, etc., it is necessary to assemble the results from plots treated similarly throughout the different series.

Comparison of stable manure vs. commercial fertilizer. The following figures are obtained by averaging the results per acre from the best plots of Series A and B.

Manure (average of heavy and light applications) gain over check plots $186.25.

Commercial fertilizer (average of heavy and light applications) gain over check plots—$198.40.

There is thus a gain per acre of $12.15 for the commercial fertilizer.

Comparison of plowing down commercial fertilizer vs. applying it on plowed ground as top dressing harrowed in just before crop was planted. The following is an average of the results per acre in Series A and B.

Commercial fertilizer plowed down, gain over check plots $198.40.

Commercial fertilizer top-dressing on prepared land, gain over check plots $174.90.

This comparison shows a gain per acre of $23.50 in favor of plowing down the fertilizer. By referring back to the tables showing the annual crops, it will be noticed that these gains are mostly obtained by the better yields when cabbage was the crop planted. The potato crops did not seem to be affected to such an extent. This, however, would not justify the inference that cabbage should have the fertilizer plowed down and potatoes should not, because in the season of 1905 the result on Series B shows the gain to be in favor of plot 7 upon which the fertilizer was sown on top just before cabbage was planted. From the experience in this work and other observations without having made any specific experiments it would seem fair to infer that the difference in favor of plowing down the fertilizer, may be attributed to the length of time the application had been made before the crop was planted, for in the case of the potatoes the crop was planted shortly after the fertilizer was plowed down, while the cabbage was not planted until six to ten weeks had elapsed except in the season of 1905 when the fertilizer plowed under was applied only two weeks before the surface dressing was done. The fertilizing materials when applied some time before crops are planted no doubt become well distributed throughout the soil, and probable aid in bringing about many beneficial changes.

Comparisons of heavy and light applications of commercial fertilizers. These results are averages per acre from series A and B. Commercial fertilizer, heavy application, 2150 lbs. per acre, gain over checks $153.75.

Commercial fertilizer, light application, 750 lbs. per acre, gain over checks $220.72.

The gain for the light application is $66.97. If series B alone were taken to make this comparison the difference would not have been quite as great. This work seems to justify the conclusion that 750 pounds of commercial fertilizer per acre annually is more profitable than three times that amount on the kind of soil used and under the conditions that prevailed during the years in which the test was conducted.

Comparison of heavy and light applications of stable manure.—These results are averages per acre from series A and B. Heavy application—15 tons per acre—gain over checks $213.50. Light application—6 tons per acre—gain over checks $131.75.

The gain for the heavy application is $81.75 per acre. This bears out to some extent what has long been the practice of farmers. There is no doubt, however, that much stable manure is wasted and if lighter dressings supplemented with commercial fertilizers were used, the results would be better.

Comparison of fresh and rotted stable manure.—These results were obtained from five crops on series C, the crops being in the order given: Potatoes, peas, tomatoes, potatoes and cabbage. Fresh manure 20 tons per acre, net loss $35.95 per acre compared with check plots. Rotted manure 20 tons per acre, net gain $14.55 compared with checks.

For these crops the rotted manure was the most desirable. This is probably in some measure due to the greater availability of the plant food in the rotted manure. Since the fresh manure was applied in the winter it might be possible that some of the plant food was carried away by heavy rains on a frozen surface. Also, at the time of plowing in the spring the strawy parts of the fresh manure were in a perfectly unbroken and almost unchanged form while the strawy portion of the rotted manure was at least partly available as plant food.

Comparison of rotted manure which was turned vs. that unturned in the process of decay. These results are the average per acre of five crops on series C.

Rotted manure, turned, gain per acre over checks $14.55.

Rotted manure, unturned, gain per acre over checks, $2.60.

The experiment shows that it pays to turn manure while in process of decaying. The operation not only prevents some loss of plant food, but it mixes and distributes the strawy bunches through the pile, so that, when ready to be spread the whole pile is in uniform condition.

Comparison of commercial fertilizer derived from mineral sources vs. those derived from animal and vegetable sources. This is the average per acre of three crops in series C.

Mineral fertilizers, net gain per acre over checks $54.20.

Organic fertilizers, net gain per acre over checks $47.20.

By taking the three profitable crops on series C and averaging the results as above, the mineral fertilizers are shown to be the most profitable. On the other hand, if the comparisons are made between the plots the two seasons that the dependence was on the residue left in the soil, the organic fertilizer plots gave the greater profit. The common practice of combining the two is no doubt the correct one.

REVIEW AND CONCLUSIONS.

In reviewing the above work as a whole there would seem to be some contradictions. In series A and B the plowed down plots were invariably in the lead. In series C, however, this was not the case for only in one season did the plots treated this way give a slightly increased yield.

Also in Series A and B the fertilizer and manures whether sowed on the surface or plowed down made gains enough to show a handsome profit. In Series C, plot 1, a manure plot was worked at a loss and all the commercial fertilizer plots were very much behind.

Considering the series separately it would seem that series A had been operated for the greatest gain. This was helped considerably by the hay crop which came in as a catch crop and left the land so that a good crop of cabbage followed. One fact to be noted is that on Series A there was no greater profit from the application of 15 tons of manure per acre than from the application of 750 lbs. of commercial fertilizer costing only one-third as much, without regard to the cost of applying which is in itself an expensive item.

The figures in the tables while being relatively all right for comparison cannot be taken as being absolutely as correct as if all the crops were sold and accounts kept. There is no doubt that if everything had been sold the check plots would not have stood so high as they do in most cases, especially the cabbage crops, because the grade of the stock grown was very poor.

The tests on series C, as to the best manner for the market gardener to handle his manure, did not turn out as was expected when viewed from the standpoint of what is considered the best farm practice. It has been advocated for some time that the farmer would better get his manure out on the land as soon as possible to avoid waste. This may be true when corn is the principal crop grown and sod land available upon which to spread the manure, but in vegetable growing it seems to be necessary to subject the manure to some treatment that the strawy part may be decomposed and become available as plant food. The table shows that plot 2 upon which the manure was turned to prevent burning, was the most profitable plot and next to this in profit was plot 3 upon which the manure was piled and not turned.

Regarding the question of mineral fertilizers as against the animal waste fertilizers, the results show that crops were just as good and indeed generally a little better where the mineral fertilizers were used. The land does not appear to have suffered in any respect from their use.

If we take a summary of the whole of the series it will not be very apparent that any benefit was derived from plowing down the fertilizer; neither was there any waste from doing so.

It would appear from the above work that for such crops as those used, the larger amounts of manure cannot be profitably applied.

In series C, there was a loss in using 20 tons of manure or its equivalent in commercial fertilizers.

Series A, was quite profitable and the 750 pounds per acre of fertilizer gave very nearly as large yields as larger applications and considerable more profit.

Seven hundred and fifty pounds of commercial fertilizer on series B, also did well, and the use of six tons of manure always gave about the same yield.

From this work and other experiments and observations it seems necessary to put the land in grass every few years if summer crops are to be grown. Late cabbage especially does not do well on land that has been cropped every year; but if a piece of sod land, even if somewhat thin, can be given 750 lbs. of commercial fertilizer with a light dressing of stable manure, it will invariably produce a good crop. The application of a great deal of manure and fertilizers seems to bring about a condition that in seasons of excessive rains coupled with much heat, is very detrimental to the growth of plants which are natives of a temperate climate.

SUMMARY.

Stable manures always increased the yields, but valued at $2.00 per ton did not give as much profit as commercial fertilizer.

Fresh manure spread in winter did not give as much increase as the same amount rotted and plowed down at same date in the spring.

Turning the manure while rotting was better than leaving it without being turned.

Commercial fertilizers plowed under in the spring invariably gave larger yields than when sowed on the surface just before planting in the summer.

About 750 pounds of commercial fertilizers seemed to be more profitable than three times that amount.

Continuous crops of sweet potatoes on same land does not appear to be bad practice.

The quality of the crops, cabbage and potatoes especially, grown upon the check plots, was of very poor grade.

The soil on plots heavily dressed with mineral fertilizers does not seem to have been changed or injured any more than where the organic fertilizers were applied.

The seasons through which this work has been followed have all been very moist and some were quite wet.

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MISCELLANEOUS GREENHOUSE NOTES.

By C. P. Close, Thos. H. White and W. R. Ballard.

INTRODUCTION.

During the past eight years various lines of interesting work have been carried on in the greenhouse, but as there was not at any time enough material under any one subject to justify publishing in bulletin form, the results have accumulated until it seems desirable now to include everything in brief form in one report. Mr. Thos. H. White has had charge of all this work since its inception. Prof. W. N. Hutt and Mr. S. B. Shaw are hereby given credit for assistance and suggestions on these lines of work while they were connected with this Experiment Station.

FERTILIZER IN SOLUTION ON CHRYSANTHEMUMS AND LETTUCE.

In Bulletin No. 81 of this Experiment Station, are recorded some experiments conducted in previous years with fertilizers in solution on chrysanthemums. The work showed that the plain cow excrement was of very little value as a stimulant or as it is more commonly called a "food" for the chrysanthemums, in producing blooms of large size and of good finish. This was not the case, however, with the urine of the animal. This, when supplemented with phosphates, seemed to give very good results.

There was also some work done with chemical fertilizers in solution, enough being used to approximate the amounts of nitrogen, phosphoric acid and potash found in the animal urine. The work as planned in the above bulletin has been continued and the results follow.

Several formulas were used in this work and these were changed or added to as circumstances seemed to warrant. Table I shows the formulas and quantities of each of the several things used and the number of seasons tried. The nitrate of potash was put into the experiment because it was thought that this material, being almost pure nitrogen and potash, might be very much better for greenhouse work than nitrogen and potash in other combinations. This did not prove to be the case, however, so that it was dropped. The sheep manure water has been tried three seasons and has apparently done a little better than either of the other mixtures. The cow urine and dissolved S. C. rock, and the muriate of potash, nitrate of soda and dissolved S. C. rock mixtures, have been used the most and have given good results. The flowers upon the plot receiving the chemicals have been quite as good and sometimes a little better than upon the plot receiving the cow urine.

With regard to the sheep manure, there is of course a certain amount of fiber that becomes mixed in the water even though the material is placed in a coarse sack and suspended in the water in this manner. After a few waterings this fibrous matter forms a light mulch over the surface, which seems to induce healthy and vigorous root development upon the surface of the soil. This is rarely seen where the chemicals are used and it may be that this would account for the somewhat better results secured upon this plot. The chemicals, however, are so easily obtained and are so readily soluble and odorless, a feature which would be quite a recommendation in some places, that they should be used in preference to the liquid animal manures. . If it was thought worth while, a light mulch of well rotted manure, used in connection witih the chemicals, should secure about the same results.

Table I. Shows Kind of Fertilizers in Solution Used on the Plots for Five Years and the Weight and Number of Chrysanthemum Blooms and the Length of the Stems Produced.

Year.	PLOT 1. Cow urine and dis. S. C. rock.			PLOT 2. Nit. of soda, muriatc of potash and dis. S. C. rock.			PLOT 3. Nothing.			PLOT 4. Dried blood, dis. S. C. rock and muriate of potash.			PLOT 5. Sheep manure and dis. S. C. rock.			PLOT 6. Nitrate of potash and dis. S. C. rock.		
	Blooms.			Blooms.			Blooms.			Blooms.			Blooms.			Blooms.		
Year.	Weight. oz.	Size. inches.	Length of stem. inches.	Weight. oz.	Size. inches.	Lentgh of stem inches.	Weight. oz.	Size. inches.	Length of stem inches.	Weight. oz.	Size. inches.	Length of stem inches.	Weight oz.	Size. inches.	Length of stem inches.	Weight. oz.	Size. inches.	Length of xtem inches.
1902	48	....	......	46	....	......	43	....	......	....	....	......	....	....	......	50	....	......
1003	29	....	......	26	....	......	24	....	......	....	....	......	....	....	......	28	....	......
1904	66	....	......	79	....	......	50	....	......	60	....	......	57	....	......	....	....	......
1905	67	5.3	34.8	75	5.5	34.8	69	4.9	39.6	64	4.9	36.0	72	5.4	37.2	....	....	......
1906	68	5.0	38.4	75	5.3	33.6	47	4.7	33.6	66	5.3	34.8	77	5.6	38.4	....	....	......
Average.	55	5.2	36.6	60	5.4	34.1	46	4.8	36.6	63	5.1	35.4	68	5.5	37.8	39	....	......

RESIDUAL EFFECT OF FERTILIZER SOLUTION ON LETTUCE.

In the rotation used in the greenhouse, lettuce invariably followed the crop of chrysanthemums and it was thought well to keep a record of the several plots that had been used in the "fertilizers in solution experiment," to note what effect the fertilizer remaining in the soil would have upon the succeeding crop. The records of the lettuce are given in Table II, and the results in the main correspond with those obtained in the chrysanthemum work.

Table II. Shows the Kind of Fertilizer Used on Each Plot and Yield of Lettuce on Each Plot.

Year.	Crop.	Plot 1. Cow urine and dissolved S. C. rock, (8 gallons of urine to one pound of rock)	Plot 2. Nitrate of soda, muriate of potash and dissolved S. C. rock.	Plot 3. Nothing.	Plot 4. Dried blood, muriate of potash and dissolved S. C. rock.	Plot 5. Sheep manure and dissolved S. C. rock.	Plot 6. Nitrate of potash and dissolved S. C. rock.	Plot 7. Cow urine, (8 gallons to 48 gallons of water.)	Plot 8. Sulfate of ammonia, muriate of potash and dissolved S. C. rock.	Plot 9. Sheep manure.	Plot 10. Nitrate of soda and muriate of potash.
		Weight, ounces	Weight, ounces.	Weight. ounces.	Weight, ounces.	Weight, ounces.	Weight, ounces.	Weight, ounces.	Weight, ounces.	Weight, ounces.	Weight, ounces.
1901	First.	135	90	72	....	....	....	120	75	....	....
1902	"	....	....	52	....	....	....	62	....	....	82
	Second.	....	....	40	....	....	....	51	....	....	70
1903	First.	23	21	22	....	....	23	....	....	....	....
	Second.	50	76	19	....	....	77	....	....	....	....
1904	First.	61	66	64	....	....	....	....	....	48	....
	Second.	68	69	34	....	....	....	....	....	67	....
1905	First.	14	42	12	16	21	....	....	....	....	....
1906	"	59	58	53	54	58	....	....	....	....	....
	Second.	92	90	72	62	96	....	....	....	....	....
1907	First.	42	37	23	34	44	....	....	....	....	....
	Second.	76	76	35	58	64	....	....	....	....	....
Average.......		62	62	49	45	56	50	75	75	57	76

COVER CROP SOILS FOR USE IN GREENHOUSE IN GROWING CHRYSANTHEMUMS AND LETTUCE.

The procuring of suitable soils for greenhouse work is often a source of considerable anxiety in the mind of the florist. There having been some experiments with cover crops in connection with orchard management started in the fall of 1901, it was suggested that soil from these several plots be used in the greenhouse. The orchard, before the cover crop experiment was started, had been well tilled and an annual crop of crimson clover had been disced in, or plowed under, in the spring. The orchard plots were treated as follows:

Plot 1 was seeded to white clover and left permanently, the growth being clipped two or three times each season and left upon the land. Plot 2 was plowed in sprng and kept harrowed until about August 1 when it was seeded to crimson clover to be plowed down the following spring. Plot 3 was plowed in the spring and sowed to cowpeas about the first of June, the stubble being left on the ground to be plowed down the following spring. Plot 4 was seeded to rye in the fall to be plowed under in the spring, and a crop of cowpeas grown and plowed under in the fall. Plot 5 was seeded to rye in the fall, this was plowed down in the spring and the ground was well tilled until it was seeded to rye again in the fall.

Plate I.—Chrysanthemums on Cover Crop Soils.
The plots numbering from right to left are: 1, sod compost; 2, rye; 3, crimson clover; 4, cowpeas and rye; 5, cowpeas; 6, clover sod.

In the greenhouse these soils were used in comparison with a soil of sod and manure compost such as is generally used in greenhouse work. All plots received a good dressing of cow manure except in the season of 1907. Plate I shows chrysanthemums in bloom in the cover crop plots.

Chrysanthemums with lettuce following, were used as a rotation on these plots for five years.

Table III. Shows Kind of Soil Used, Weight, Size of Bloom and Length of Stem of Chrysanthemums Produced on Six Plots for Five Years.

YEAR.	PLOT 1. SOD COMPOST.			PLOT 2. RYE.			PLOT 3. CRIMSON CLOVER.			PLOT 4. COW PEAS and RYE.			PLOT 5. COW PEAS.			PLOT 6. CLOVER SOD.		
	BLOOM.			BLOOM.			BLOOM.			BLOOM.			BLOOM.			BLOOM		
	Weight, ounces.	Size, inches.	Length of stem, inches.	Weight, ounces.	Size, inches.	Length of stem, inches.	Weight, ounces.	Size, inches.	Length of stem, inches.	Weight, ounces.	Size, inches.	Length of stem, inches.	Weight, ounces.	Size, inches.	Length of stem, inches.	Weight, ounces.	Size, inches.	Length of stem, inches.
1903.....	36	......	......	35	......	......	36	......	......	43	......	......	45	......	......	44	.....	......
1904.....	91	4.98	43.2	94	5.2	45.6	90	5.0	45.6	94	5.1	43.2	96	4.9	44.8	75	4.8	45.6
1905.....	65	4.8	39.6	61	4.5	36.0	75	5.1	37.2	76	5.1	34.8	72	5.2	34.8	67	4.9	34.8
1906.....	48	4.5	39.6	40	4.4	34.8	55	4.7	39.6	52	4.9	36.0	50	4.8	36.0	51	4.6	36.0
1907	48	5.1	36.0	38	4.4	32.4	34	4.6	31.2	46	4.7	32.4	48	4.9	32.4	36	4.5	28.8
Average.	57	4.87	39.6	53	4.6	37.2	58	4.8	38.4	62	4.9	36.6	62	4.9	37.0	54	4.7	36.3

In 1903 when the experiment started, only the weights of the chrysanthemums were recorded, but in the following years both the size of the blooms and the length of stems were recorded and the results are given in Table III.

The results show no remarkable difference in the plots. As a rule, however, the rye plot soil gave the poorest yields both in weight and size of flower. The foliage on this plot was usually of a light green color indicating the lack of available nitrogen in the soil. The plots with soil upon which the leguminous crops had been grown, had dark green foliage. It would seem that the value of green manures in building up and improving the soil depends to some extent upon the nature of the cover crop used. Notwithstanding the fact that rye produces a large amount of decaying organic material, its use as a green manure in the experience of the Station, has uniformly given poorer results than the other cover crops tried.

The lettuce from these greenhouse plots gave results similar to those with chrysanthemums. The yields of the various plots are given in Table IV. The sod compost gave the best results with this crop and the two cowpea soils next best. It would seem from the results of these experiments that the source of the soil is not a very important consideration for these crops if properly supplemented with manure or fertilizer.

Table IV. Shows Weight of Six Crops of Lettuce Following Chrysanthemums Produced on Soils in Greenhouse from Cover Crop Plots in Orchard.

Year.	Crop.	Plot 1. Sod compost. Weight, ounces.	Plot 2. Rye. Weight, ounces.	Plot 3. Crimson clover. Weight, ounces.	Plot 4. Cowpeas and rye. Weight, ounces.	Plot 5. Cowpeas. Weight, ounces.	Plot 6. Clover sod. Weight, ounces.
1903-4.....	First....	53	48	55	67	70	48
"	Second..	65	46	49	52	39	50
1904-5.....	First....	46	6	7	7	15	5
1905-6.....	First....	47	50	45	51	63	48
....	Second..	61	58	59	61	62	63
1906-7.....	First....	29	29	30	29	29	34
Average..	....	50	39	41	44	46	42

CHRYSANTHEMUMS AND LETTUCE—THE USE OF PHOSPHATES TO SUPPLEMENT BARNYARD MANURE.

The experiments of agriculturists and the investigations of chemists both point to the fact that in order to produce the best yields of grain crops, barnyard manure should be supplemented with some form of phosphoric acid. Experiments for years have shown that phosphoric acid usually increases the yields of such crops as wheat, oats, barley, etc. Analysis of the plant indicates that most of the phosphoric acid is in the grain or seed. The practice by florists of using large quantities of bone meal and the immensely large flowers grown as a result, tend to establish a relation between the phosphoric acid and large flowers.

To grow crops continually on solid beds in the greenhouse without change of soil but by the addition of an annual dressing of manure, it would seem necessary to supplement the manure with some form of phosphoric acid. To test this proposition a solid bed was divided into four plots and treated each year as follows: plot 1 received phosphate in an insoluble form, this being slag phosphate with the exception of one year when ground Tennessee rock was used; plot 2 received dissolved South Carolina rock; plot 3 received fine ground raw animal bone and plot 4 was the check receiving no phosphoric acid other than that contained in the barnyard manure.

The plots were annually dressed with an inch of well rotted manure and the experiment continued through seven years. The crops grown were chrysanthemums and lettuce. The soil which originally was a yellowish, smooth-feeling loam changed during the course of the experiment to a very dark color and floculated to such an extent that the particles became quite large. The amounts of fertilizers applied each year and the records of weights and measurements of chrysanthemums are given in Table V. The plots were 3x8 feet and each contained 48 plants. The varieties used were Mrs. Robinson and O. P. Bassett. The records do not show that any marked benefit was derived from the additional applications of phosphates. This was entirely different from what was expected, but can probably be accounted for by the fact that the large amount of manure applied annually supplied about 120 pounds of phosphoric acid per acre each year, this probably was nearly sufficient for the needs of the plants without the extra amounts applied in other forms. From the information at hand it would appear that well rotted barnyard manure contains considerable available phosphoric acid while the fresh manure is deficient in this respect. Thus the necessity of heavy dressings of bone meal on plants treated with liquid from fresh animal manures is explained, while soils well enriched with rotted manure do not need such heavy dressings of bone.

Lettuce was grown on the above plots after the chrsyanthemums without any further application of phosphates. The records of the weights of eleven crops are given in Table VI and the results are about the same as with the chrysanthemums.

Table V. Shows Amount and Kind of Phosphates Applied to Supplement Barnyard Manure, and Weight, Length of Stem and Size of Chrysanthemum Blooms.

YEAR.	PLOT 1.				PLOT 2.				PLOT 3.				PLOT 4.			
	Fertilizer, pounds per acre, slag phosphate.	BLOOM.			Fertilizer, pounds per acre, Dissolved S. C. rock.	BLOOM.			Fertilizer, pounds per acre, bone meal.	BLOOM.			Check, no Fertilizer.	BLOOM.		
		Weight, ounces.	Length of stem, inches.	Size, inches.		Weight, ounces.	Length of stem, inches.	Size, inches.		Weight, ounces.	Length of stem, inches.	Size, inches.		Weight, ounces.	Length of stem, inches.	Size, inches.
x1901.....	385	......	......	......	300	......	......	......	322	......	......	......	....	......	......	......
x1902.....	500	......	......	......	500	......	......	......	500	......	......	......	....	......	......	......
1903.....	500	81	......	......	500	83	......	......	500	76	......	......	....	72	......	......
1904.....	300	201	44.4	4.7	300	177	39.6	4.8	300	224	42.0	4.7	226	226	39.6	4.9
1905.....	500	119	30.0	4.5	500	111	30.0	4.5	500	129	34.8	4.7	....	181	34.8	4.7
1906.....	500	277	48.0	5.5	500	266	48.0	5.0	500	259	49.2	5.0	....	265	43.2	5.0
1907.....	2000	223	43.2	5.2	2000	206	42.0	5.0	2000	198	39.6	5.0	....	192	39.6	4.9
Average..	669	180	41.6	4.9	657	168	39.9	4.8	660	177	41.4	4.8	....	187	39.3	4.9

x No weights and measurements were taken the first two years.

Table VI. Shows Weight of Eleven Crops of Lettuce Produced on Phosphate Plots Following Chrysanthemums.

Year.	Crop.	Plot 1. Weight, ozs.	Plot 2. Weight, ozs.	Plot 3. Weight, ozs.	Plot 4. Weight. ozs.
1902	First	264	327	302	274
1902-3	First	104	82	81	84
	Second	224	221	219	200
1903-4	First	150	181	172	182
	Second	191	240	234	225
1904-5	First	195	203	224	248
	Second	192	158	172	172
1905-6	First	144	134	163	144
	Second	206	224	221	235
1906-7	First	152	137	142	150
	Second	232	248	256	266
Totals....	....	2044	2155	2185	2180

CHRYSANTHEMUMS AND LETTUCE—CONTINUOUS CROPPING WITHOUT CHANGING SOIL.

In large greenhouse establishments, the work of annually removing all of the soil from the beds and benches, and replacing it with new, is an expensive item. The necessity for this has been proven by the experience of many men at various times. The reason for the necessity is rather more obscure. The grower rarely questions the fact, but goes to work and changes the soil because it is the right thing to do in order to secure the best results. He claims that without changing the soil often it will become full of disease germs, or exhausted, or sour.

The work mentioned here has been done on, and relates to, solid beds only. Plate II shows the 1903 crop of chrysanthemums on solid beds. The necessity of removing soil to get rid of disease does not seem to be borne out under the conditions prevailing here. As to becoming impoverished, annual dressings of barnyard manure and fertilizers will overcome this difficulty. The souring of the soil seems to be the worst feature to contend with. It would seem that so called "souring" could be neutralized by the application of lime, yet in practice here this could not be done. The soils that have been used in this connection were planted to cherry trees several years before the experiment was started in 1898. The upper six inches was a yellowish, smooth loam, but did not produce much growth in the cherry trees although it had been enriched annually by turning down a crop of crimson clover. The soil was gathered in August and composted with rotted manure.

This was placed in the beds in October and lettuce was planted. The lettuce was a complete failure by not only refusing to grow, but also by being affected with various diseases. That this was not the fault of the temperature or other greenhouse conditions was plain, because some plots of garden soil in the same house produced good heads of lettuce comparatively free from disease. After more manure had been applied, another crop of letture was tried and yielded satisfactorily. Chrysanthemums planted the following summer were very fine as was also the lettuce which followed the chrysanthemums as a midwinter crop. The bed had an annual dressing of an inch or so of well rotted manure. One crop of chrysanthemums and two crops of lettuce have been grown each year on this soil since 1898. Plates III and IV show the appearance of the crops for the seasons of 1905 and 1906.

Plate II.—Soil used continuously without change. Mrs. Robinson's Chrysanthemums, 1903.

There has been no disease of any account and until a year ago it looked as though the soil could be used over and over. The soil has changed very much in appearance being now very dark in color and quite granulated. There are a good many small earth worms and insect larvæ present, usually seen feeding upon decaying vegetable matter. The chrysanthemums a year ago first showed signs of not having congenial conditions in the soil. The lower leaves in the late fall became spotted and fell off. Upon examination the roots were found to be of a brownish or rusty color with an entire absence of young healthy white feeders. The plants had all the appearance of being overwatered and yet the greatest care was taken in this respect, to keep the soil barely moist.

The same condition continued for the crop of lettuce following, but the second crop of lettuce did well. The chrysanthemums of the past season while making a good growth and fair flowers, seemed to be affected in much the same way.

This condition of course interferes with the profitable continuance of this plan of never changing the soil. The chemists seem unable to explain or to correct the trouble. The inference is that the conditions are similar to that found in reclaimed peat bogs where no treatment except stirring and weathering seems to have any beneficial effect. Lime both in the form of caustic and the carbonate seems to be ineffective.

As the weather gets cooler the condition of the soil seems to improve as is evidenced by the fact that the lettuce of the second crop in 1906, which was planted in February, was quite up to normal.

Plate III.—Soil used continuously without change. Rawson's Crumpled Leaf Lettuce, 1905.

Observations on out door work with soils which seemed to be affected in the same way, point to the fact that some particular types of plants of tropical or sub-tropical origin which are fond of heat and moisture, such as cannas, corn, caladiums, etc., do well on these soils; while cabbage, celery, lettuce and such plant, natives of a temperate climate, give much less satisfactory results. The large amount of organic matter supplied in the form of rotted manure and coupled with rapid fermentation in hot weather, probably induces excessive amounts of some chemical compound which is injurious to some plants.

These soil problems seem very difficult to solve and the grower who provides for an annual supply of fresh soil will in all probability take the safest course.

CARE OF SOLID BEDS.

Observations here and experiments at other stations show the absolute necessity of taking care of the soil in the solid beds that are to be planted the following year. If it is possible and profitable it is best to grow some crop and thus keep the soil in a suitable condition.

Where lettuce is to be grown, chrysanthemums planted in June will sell at greater profit in the fall than lettuce and the plants can be removed in time to get in the midwinter crop of lettuce. If a growing crop cannot be used, cover with strawy manure and water occasionally through the summer, sufficiently to keep the beds moist. A moist condition is favorable to the bacterial colonies which are so valuable in making plant food available.

TESTS OF EXTRA LARGE AMOUNTS OF NITROGEN IN INFLUENCING EARLY GROWTH AND BLOOM OF CARNATIONS.

This experiment was started in the Fall of 1904 to test the stimulating effect of nitrates in different forms and in different amounts as follows:

Plot 1—Nitrate of soda at the rate of 100 pounds per acre.
Plot 2—Nitrate of soda at the rate of 200 pounds per acre.
Plot 3—Nitrate of soda at the rate of 300 pounds per acre
Plot 4—Check.
Plot 5—Dried blood at the rate of 500 pounds per acre.
Plot 6—Rotted manure at the rate of 9000 pounds per acre.

Plate IV.—Soil used continuously without change. Grand Rapids Lettuce on Solid Bed.

The variety, Mrs. Lawson, was used and the records are found in Table VII. The majority of the plots show negative results for the two seasons tried. The 300 pounds of nitrate of soda and 500 pounds of dried blood showed superiority over the check plot only in number of blooms per plant. The dried blood alone gave longest stems while the check plot had the largest flowers. There were 12 plants on each plot.

Table VII. Shows Amount of Fertilizer Applied to Each Plot, and the Average Number and Size of Blooms and Length of Stems Per Plant for 1904-5 and 1905-6.

Plot.	Fertilizer.	Blooms per plant	Size of blooms inches.	Length of stems, inches.
1	100 lbs. nitrate of soda....	15.2	2.60	17.0
2	200 " " " "	15.9	2.55	17.9
3	300 " " " "	17.4	2.65	18.0
4	Check, no fertilizer.......	15.9	2.70	18.4
5	500 lbs. dried blood........	16.5	2.60	18.9
6	9000 lbs. rotted manure...	15.2	2.60	18.4

EFFECTS OF FERTILIZER UPON THE STIFFNESS OF STEMS OF CARNATIONS.

During the seasons of 1904-5 and 1905-6, different fertilizers were used on carnations to determine the effect of nitrogen, phosphoric acid and potash on the stiffness of the stems. The first year, plot 1 received at the rate of 8100 pounds of dried sheep manure per acre. Plot 2 received 1400 pounds of dried blood, 300 pounds of sulphate of potash, and 2000 pounds of dissolved S. C. rock per acre. Plot 3 received 2000 pounds of dissolved S. C. rock. Plot 4 was a check plot. Plot 5 received 300 pounds of sulphate of potash per acre. Plot 6 received 1400 pounds of dried blood per acre. The next year the same fertilizers were used, but the amounts were doubled. The variety, Mrs. Lawson, was grown for this experiment. A simple apparatus was constructed to test the bending strength of the stems. After being cut to the required length, the stem was fastened at the base so as to hang horizontally and the natural bend read on a vertical scale. A ten grain weight was then added just at the base of the calyx and the scale again read, the difference between the two readings was taken as the basis for judging the relative stiffness of the stems.

The records are found in Table VIII. The results clearly indicate that the use of phosphoric acid gives the stiffest stems and that potash ranks next. Nitrogen in the form of dried blood gave very weak stems. The table shows, however, that there are factors other than the stiffness of the stem to consider in the successful growing of carnations. Plot 2 which received a complete fertilizer, gave a considerably larger number of flowers per plant, and longer stems than any of the other plots. The size of the flowers were as large as the average and larger than those on the phosphoric acid plot. It would seem, therefore, that for the best results it would be advisable to use a fertilizer containing a mixture of nitrogen, phosphoric acid, and potash with phosphoric acid in excess.

Table VIII. Shows Amount and Kind of Fertilizer Applied, the Size and Number of Carnation Blooms per Plant and the Length and Comparative Stiffness of Stems Averaged for the Seasons of 1904-5 and 1905-6.

Plot.	Fertilizer.		Blooms.			Comparative Stiffness.		
	Amount, pounds per acre.	Kind.	Number per plant.	Size.	Length of Stem.	Natural Bend.	Bend with added weight 10 grams.	Difference in bend.
1	8100	Dried sheep manure	15.3	2.6	16.8	66.37	127.16	60.79
2	1400	Dried blood.	....	......	....	....	....	....
....	300	Sulphate of potash.	....	......	....	....	....	....
....	2000	Dis. S. C. rock.	18.0	2.6	18.7	69.63	130.19	60.56
3	2000	Dis. S. C. rock.	14.3	2.55	17.0	56.03	101.44	45.41
4	......	Check.	14.4	2.6	17.5	62.57	117.26	54.69
5	300	Sulphate of potash.	15.0	2.6	17.9	65.67	117.15	51.48
6	1400	Dried blood.	16.5	2.6	18.5	78.39	150.89	72.50

DIFFERENT TIMES OF SETTING CARNATIONS.

A five years' test to determine the best time of planting carnations in the greenhouse, was concluded in the Spring of 1906. Cuttings for all plots were made on the same date. The plan followed was to grow the plants for plot No 1 in pots in the greenhouse while those for the other plots were planted in the field in April. Those in pots and one lot from the field were transplanted to the greenhouse benches about July 1. Plots 3 and 4 were transferred to the greenhouse from the field August 1 and September 1 respectively. The variety, William Scott, was used in the test the first year while Mrs. Thos. W. Lawson was used during the succeeding seasons. Only the number of blooms per plant was recorded during the first three years of the test, but in the later crops the size of the bloom and the length of the stem were measured. These data are given in Table IX.

The results indicate that the September planting gives a considerably larger number of blooms per plant, the number decreasing the earlier the planting was made. The largest blooms and the longest stems, however, seem to be produced on the early plantings.

Table IX. Shows for Five Seasons the Time of Planting from Pots or Field; the Number and Size of Blooms and Length of Stems Produced and the Average Results of all Plots.

SEASON.	PLOT 1. Planted July 1 from pots.			PLOT 2. Planted July 1 from field.			PLOT 3. Planted August 1 from field.			PLOT 4. Planted September 1 from field.		
	BLOOMS.			BLOOMS.			BLOOMS.			BLOOMS.		
	No.	Size, inches.	Length of stem inches.	No.	Size, inches.	Length of stem, inches.	No.	Size, inches.	Length of stem, inches.	No.	Size, inches.	Length of stem, inches.
1901-2...	9.1	.....	......	11.6	.....	......	......	......	......	8.5	......	......
1902-3...	9.2	......	......	15.6	......	......	......	......	......	19.0	......	......
1903-4...	12.9	.....	......	12.2	......	......	16.8	......	......	23.1	......	......
1904-5...	7.5	2.7	18.5	7.5	2.7	18.8	14.5	2.6	19.2	18.3	2.5	18.4
1905-6...	5.6	2.7	17.8	9.5	2.6	18.9	10.2	2.7	17.8	17.2	2.6	15.7
Average.	8.86	2.7	18.1	11.2	2.65	18.85	13.8	2.65	18.5	17.2	2.55	17.05

CARNATIONS—CONTINUOUS CROPPING WITHOUT CHANGING SOIL.

The experiment in continuous cropping of carnations was similar to that already mentioned with chrysanthemums and lettuce. Instead of manuring and stirring six inches of the surface soil, the bed was double dug, that is, the spading was so done that 10 inches of the lower soil was brought to the surface and the upper 10 inches was placed below. This method has been continued for the past five years. One-half of the solid bed was treated in this way and the other half had new soil annually. The plants on the new soil generally yielded more flowers, and taking an average of the five years, gave two flowers per plant more than those on the continuously used soil.

All the plants made a satisfactory growth, however, and there were not more diseases on the plants in the old soil than there were in the new bed.

THE BURSTING OF CARNATIONS DUE TO LOCATION ON GREENHOUSE BENCHES.

It was noticed that the row of carnations located near the glass of the side benches produced more bursted flowers than did the other rows on the benches. During the winters of 1904-5 and 1905-6, a record was kept of the good flowers and the bursted flowers on the different rows. Table X shows that the row nearest the glass produced 21 per cent. of bursted flowers while only one other row gave as high as 7 per cent.

The reason usually assigned for this trouble, is that plants hardened off by being grown on soil kept rather dry or by having the growth checked in other ways, are likely to produce a larger percentage of bursted flowers when over stimulated by addition of rich food or of moisture. In this case it was found almost impossible to secure uniform conditions near the glass, the soil drying out badly although receiving a normal supply of water. Many growers find less trouble with this bursting of the calyx when the benches are so placed as to allow a walk between them and the side walls.

Table X. Shows Total Number of Good Blooms, and Total Number and Percentage of Bursted Blooms for the Seasons of 1904-5 and 1905-6.

Row.	BLOOMS.		
	Good.	Bursted.	
	Number.	Number.	Per cent.
1 { near glass. }	797	172	21
2	731	47	6
3	780	62	7
4	825	57	6

SUB-IRRIGATION VS. SURFACE WATERING FOR LETTUCE AND CARNATIONS.

Numerous reports of striking gains in yields and marked immunity from disease in supplying water to the roots of plants in underground irrigation systems, led to the following tests of the comparative value of sub-irrigation and surface watering. This test was started in the greenhouse during the season of 1899-1900, using lettuce as the crop.. Three beds were prepared with sub-irrigation systems with corresponding plots to be watered on the surface. The underground systems consisted primarily of a cement basin provided with overflow outlets at a height of three inches. Plot 1 had bricks with the lower edges chipped off, laid in the bottom of the cement basin to allow circulation of water. Plot 2 was provided with one line of two-inch tile, and plot 3 had two lines of two-inch tile.

Rich soil to the depth of six inches was placed in these plots and two crops of lettuce were harvested from all plots. Table XI gives the weights of lettuce produced on each plot and the total yields.

One crop of lettuce was grown on sub-irrigated and surface watered plots in 1905, with results similar to those given in the above table. The weights of lettuce produced on the two plots, were 67 ounces and 71 ounces respectively.

Table XI. Shows Weights of Two Crops of Lettuce Produced on Sub-Irrigated and Surface Watered Plots in Season of 1899-1900.

Crop.	PLOT 1.		PLOT 2.		PLOT 3.	
	Sub-irrigated, brick bottom.	Surface watered.	Sub-irrigated, one line of tile.	Surface watered.	Sub-irrigated, two lines of tile.	Surface watered.
	Weight, ounces.	Weight, ounces.	Weight, ounces.	Weight, ounces.	Weight, ounces.	Weight, ounces.
First	105	95	86	86	95	93
Second	98	110	92	100	105	112
Total..	203	205	178	186	200	205

A similar test using carnations as the crop was begun in the Fall of 1901 and continued for four years. The variety William Scott was used the first season and Mrs. Thos. W. Lawson in those following. No records were kept for the first two years except the number of blooms produced. During the last two years the size of the bloom and the length of stem were also recorded. These results are given in Table XII.

Table XII. Shows Number and Size of Blooms and Length of Stems of Carnations Produced on Sub-Irrigated and Surface Watered Plots for Four years.

YEAR.	PLOT 1—SUB-IRRIGATED.			PLOT 2—SURFACE WATERED.		
	BLOOMS.			BLOOMS.		
	Number per plant.	Average size inches.	Length of stem inches.	Number per plant.	Average Size inches.	Length of stem inches.
1901-2............	9.3	....	....	8.6	....	....
1902-3............	17.3	....	....	23.1	....	....
1903-4............	25.1	2.6	18.5	19.7	2.6	17.2
1904-5............	14.3	2.6	16.6	15.5	2.6	16.9
Average..........	16.5	2.6	17.5	16.7	2.6	17.5

The result of these experiments seem to indicate that sub-irrigation does not give enough better results to warrant the extra expense of construction. When carefully and thoroughly done, the surface watering gave very satisfactory results in yield and quality of product with no more trouble from disease than was true with plants sub-irrigated.

SOLID BEDS VS. BENCHES FOR TOMATOES, CARNATIONS AND LETTUCE.

The difference of opinion in connection with the growth of crops upon an ordinary solid bed or upon raised benches with heating pipes beneath, continues to be an interesting one with greenhouse men. Many establishments have both styles and get good results from each. Like many other problems relating to horticulture, conditions enter largely into the question of which some are,—the crops to be grown, value of lumber to renew benches, liability of the soil to become infested with disease spores and insects.

The items herein noted have been gathered from the work with various crops.

The solid bed, running through the center of the house, was 8 feet 6 inches wide and 2 feet deep. The benches were 2 feet and 6 inches above the floor with hot water pipes beneath. They were 3 feet and 8 inches wide, 6 inches deep, and were placed within 8 inches of the glass sash on the side walls.

Six inches of the surface soil of the solid bed was renewed each year. All of the soil on the benches was taken off and replaced by new soil annually.

With regard to diseases, it can not be said that there were any more on solid beds than on benches. Regarding insects, however, the nematode worm got into the solid bed planted in tomatoes and lived over from year to year usually interfering a good deal with the second crop.

Data on crops of tomatoes, carnations and lettuce are available for comparison of this work.

Tomatoes—The average of four crops per plant on benches was 10.4 fruits, weighing 2 lbs. 3 ozs. The average on solid beds was 13.1 fruits, weighing 2 lbs. 2 ozs. The fruits ripened on both beds at the same time and there was practically no real difference in results except that the fruits from the benches were slightly larger than the others and the plants on solid beds continued to produce fruit later in the spring than did those on benches. The solid bed was easier to water than the benches.

Carnations—The average results of two crops produced on benches and solid beds follow:

Benches—15.9 blooms, size 2.7 inches, length of stem 17.8 in.
Solid beds—17.4 blooms, size 2.5 inches, length of stem 17.0 in.

About the only difference apparent in the above table is the extra flowers per plant on the solid bed. This was probably due to the better growth in late Spring and the plants were always more robust on the solid beds.

Lettuce—The records show that while the midwinter crop was usually about equal on the solid bed and bench, the Spring crop was heavier on the solid beds.

VARIETY TEST OF TOMATOES IN THE GREENHOUSE.

In the Spring of 1899, several of the ordinary garden varieties of tomatoes were tried in the greenhouse to compare with the Lorillard, a variety quite generally used for forcing. The fruit was considerably affected by rot and only a few of the perfect fruits were weighed. The yields were calculated from the weight of an average sized fruit. The record of the results, which are approximate only, are given in Table XIII.

Table XIII. Shows Varieties of Tomatoes and Weight of Fruit per Plant in 1899 and 1900.

Variety.	Year, 1899 Weight of fruit per plant. oz.	Year, 1900. Weight of fruit per plant. oz.
Lorillard	60	46
Brinton	90	
Acme	84	50
World's Fair	100	
Bond Early	80	
Dwarf Aristocrat	60	8
Climax	60	25
Atlantic Prize	48	
Paragon	60	
Freedom		12
Ponderosa		37
Stone		50
Chemin		40
Beauty		50
Enormous		6
Early Bird		9
Buckeye State		36
Royal Red		27
New Queen		25
Matchless		56

A similar test with a larger list of varieties was concluded the following Winter. The fruit was weighed and the yields calculated per plant. The results indicate that those varieties commonly grown in the field succeed under glass equally as well as the Lorillard. It was found, however, that the fruit of these varieties did not find nearly so ready a sale during the winter as that of the Lorillard because of their larger size, the winter demand being for medium sized fruits.

A second crop was left to pollinate itself naturally, but no records were kept. A few varieties such as Dwarf Aristocrat had an average set of fruit, but in general practice it has been found necessary to pollinate most varieties artificially as the set of fruit depends almost entirely upon this hand pollination.

DISTANCE APART TO PLANT TOMATOES IN GREENHOUSES.

In the Fall of 1901 an experiment was started to test the planting of tomatoes in the greenhouse at different distances apart. The plants were pruned and trained to a single stem. The variety, Sutton's Best of All, was used the first year and Lorillard in the three years following. In plot 1 for the first crop the plants were set 1x1 feet and in plot 2, 1x2 feet. The first yielded 690 ruits weighing 122 pounds while the latter yielded only 450 fruits weighing 105 pounds. In this case the closer planting seemed to give the best results except that the fruit did not color up as well as did that on plot 2. To overcome this difficulty the second crop on plot 1 was planted ½x2 feet apart thus occupying the same amount of space, but at the same time allowing a greater amount of sunshine between the rows. The results of this crop show that the closer planting still gave more fruit per 100 square feet of space, but did not weigh as much by one pound as did the wider planting. The color of the fruit in plot 1 was better than in the first crop, but still not as good as that from plot 2. On account of this lack of color it was thought best to increase the distance between the plants so that for both crops of the season of 1902-3, plot 1 was planted 1x2 feet and plot 2, 2x2 feet. The yield found in Table XIV show results in favor of the closer planting.

Table XIV. Shows Distance Between Tomato Plants, Number of Crops, Number and Weight of Fruits per Plant and the Number and Weight of Fruits per 100 Square Feet of Space.

Year.	Crop.	Distance between plants, feet.	Average number of fruits per plant.	Average weght of fruit per plant ounces.	Number of fruit per 100 square feet of space.	Weight of fruit per 100 square feet of space, pounds.
1901-2	First	1x1	6.9	19.2	690	120.0
"	"	1x2	9.0	33.6	450	105.0
"	Second	1x2	8 9	19.1	445	59.6
"	"	½x2	4.9	9.4	490	58.7
1002-3	First	1x2	8.7	29.2	435	91.2
"	"	2x2	12.4	49.1	310	76.7
"	Second	1x2	9.9	24.5	495	76.5
"	"	2x2	16.0	49 2	400	76.8
1903-4	First	2x2	15.7	49.0	392	76.5
"	"	2x2½	16 4	57.2	326	71.5
"	Second	2x2	12.0	32.2	300	50.3
"	"	2x2½	11.7	40.0	234	50.0
1904-5	First	2x2	19.8	86.1	495	134.5
"	"	2x2½	15.5	68.2	310	85.2

Three crops, two in the season of 1903-4 and one in 1905, were raised, in which plot 1 was planted 2x2 feet and plot 2, 2x2½ feet. The results indicate that the latter distance is too far apart for the most profitable returns. It is, however, difficult to draw any definite conclusions from the data available because all the different distances apart were not tested during the same seasons and under the same conditions.

The records of these tests are found in Table XIV, which gives the distance apart, the number of crops raised, the number and weight of fruit produced per plant and the number and weight of fruit produced per 100 square feet of space.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 128. JUNE, 1908.

THE EFFECT OF ANIMAL DIGESTION AND FERMENTATION OF MANURES ON THE VITALITY OF SEEDS.*

By Edward Ingram Oswald.

The investigations reported upon in this bulletin were done under the direction of the Experiment Station and all of the material, apparatus, &c., used was supplied by them. The work as planned and carried out at first was limited to a study of the effect of the fermentation of manure upon the vitality of weed seeds and was taken up at the suggestion of Prof. W. N. Hutt, then horticulturist of this Station. After this part of the work was completed the Director of the Station suggested the broadening of the work so as to include a study of the effect of the passage of seeds through the digestive system of animals upon their vitality.

These investigations were undertaken so as to give some detailed knowledge on these points and enable farmers to know something more definite as to the risks involved in introducing new weeds through the purchase of manure; hay and other feed stuffs. It was also hoped that some data would be procured which would enable farmers to follow such plans as would reduce the liability of introducing new seeds to a minimum.

In former years the catalog of Maryland weeds did not include the large number of species that it does today. It is quite evident from this fact that new ones have been brought hither through agencies favorable to their distribution.

Some of these may have been carried by floods, winds or birds; but probably the most common medium for transporting injurious seeds into a community is through the carloads of manure shipped from cities and also through the loads of hay, straw and grain that are procured from distant markets.

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*This piece of work was done under the direction of the Experiment Station and the matter was submitted as a thesis for the B. S. degree in horticulture June, 1908, Maryland Agricultural College.

Weed seeds may find their way into manure from two different sources; first by passing through the body of the consuming animal, and second by falling from the feeding racks or from among the bedding. In the first part of this particular investigation the latter method was followed out as the most plausible source of these injurious seeds.

The economic importance of this subject was first brought to prominent notice through the frequent inquiry of the truck gardeners as to the likelihood of introducing new weeds by means of the manure that they purchase from the city.

A second inquiry comes from the general farmer, who also asked if it was a dangerous practice to throw all the filth that accumulates on the farm upon the barnyard, pound or manure pile instead of burning it, and whether such a practice is likely to scatter the weeds over all parts of the farm?

A third inquiry is made by the dairymen, who questioned whether it is possible to introduce noxious weeds upon the dairy farm by buying hay, grain and mixed feeds.

In order to be able to answer these inquiries, it is necessary to investigate the effects of manure upon the germination of weed seeds under all the conditions met with in practice. These investigations were planned and conducted so as to fulfill as nearly as possible the conditions of the average farmer.

APPARATUS AND SEEDS USED.

In this test fifty-two varieties of the most malignant weed seeds found in Maryland were used.

The experiment required the following articles: A germination box, three yards of No. 20 mesh brass wire gauze, an apparatus for sterilizing soil, six Farenheit thermometers and twelve two horse wagon loads of manure, six of cow and six of horse manure.

The seeds used were secured from two separate sources. As many as possible were obtained from different localities within the State, the remainder were procured through the assistance of the United States Department of Agriculture, Bureau of Plant Industry.

The selection of the varieties used in the test was governed by making a careful examination of the Botanical Survey of Maryland and selecting therefrom the varieties known as the most noxious.

A list of seeds used will be found in Table I, together with the results of a germination test of the same.

Each variety of weed seeds to be used in the test was kept in a separate envelope, which was numbered. There were fifty-two different weeds represented in the test. In order to save time and avoid sterilizing more soil than was absolutely necessary the seeds were tested for germination, not in soil, but in a saw dust germination box, the same as used in the ordinary germination test for seed corn. The germination box was placed in a greenhouse, where it was exposed to ideal conditions for germination, and left there until the fifth day, when it was examined and notes taken. The box was examined in a similar manner every fifth day for twenty days.

The following table gives the results obtained from the germination test as observed at the four openings of the box; also the total percentage of germination, with appropriate explanation when it is found necessary.

Table I. Showing Germination Test to Ascertain Percentage of Vitality.

No.	Botanical Name.	Common Name.	No. seeds tested.	No seeds germ.	Percentage germ.
1	Comium maculatum, L.	Poison Hemlock	10	0	0
2	Ambrosia artemisiaefolia L.	Wild Tansy	10	6	50
3	Chemopodium album, L.	Lambs Quarters	10	7	70
4	Plantago lancealata, L.	Rib Grass	10	3	30*
5	Rumex Acetosilla, L.	Sheep Sorrel	10	5	50
6	Achillea Millefolium, L.	Yarrow	10	3	30
7	Ipomoea Jocq. hederacea, L.	Morning Glory	10	4	40
8	Daucus carota, L.	Wild Carrot	10	4	40
9	Solanum carolineuse, L.	Horsenettle	10	5	50x
10	Verbena pastada, L.	Blue Vervain	10	0	0

TABLE I—*Continued.*

No.	Botanical Name.	Common Name.	No. seeds tested.	No. seeds germ.	Percentage germ.
11	Solanum nigrum, L.	Common Nightshade	10	4	40
12	Echium vulgre, L.	Blueweed	10		
13	Cuscuta arvensis. Beyrich	Field Dodder	10	7	70‡
14	Amaranthus panisulatus, L.	Pigweed	10		
15	Solidago canadensis, L.	Canada Goldenrod	10	7	70‡
16	Plantago mojor, L.	Common Plantain	10	2	20x
17	Phytolacca decandra, L.	Common Poke	10	4	40
18	Malva rotundifolia, L.	Running Mallow	10	3	30
19	Amaranthus retroflexus, L.	Rough Pigweed	10	2	20x
20	Ambrosia trifida, L.	Large Rag weed	10	0	0
21	Carduus arvensis, L.	Canada thistle	10	0	0
22	Chaetochloa glauca, L.	Pigeon Grass	10	6	60‡
23	Medicago lupulina, L.	Black Medic	10	5	50

TABLE I—*Continued.*

No.	Botanical Name.	Common Name.	No. seeds tested.	No. seeds germ.	Percentage germ.
24	Verbascum blattaris, L.	Moth Mullen	10	3	30‡
25	Poa pratensis, L.	Kentucky Blue Grass	10	4	40
26	Bursa bursapastosis, L.	Shepherd's Purse	10	0	0*
27	Polygonum pennsylvanicum, L.	Persicaria	10	0	0*
28	Datura tatula, L.	Purple Thornapple	10	2	20x
29	Bromus secalinus, L.	Cheat	10	6	60
30	Cichorium Intybus, L.	Chicory	10	3	30
31	Cuscuta Epithymum, Murr.	Clover Dodder	10	7	70
32	Lepidium Virginicum, L.	Wild Pepper Grass	10	6	60*
33	Polygonum persicaris, L.	Lady's Thum	10	3	30
34	Onagra biennis, L.	Evening Primrose	10	7	70
35	Syntherisma fimbriata, Nash.	Common Crab grass	10	8	80x
36	Rumex obtusifolius, L.	Bitter Dock	10	10	100x

TABLE I—*Continued.*

No.	Botanical Name.	Common Name.	No. seeds tested.	No. seeds germ.	Percentage germ.
37	Allium cernuum, Roth.	Wild Onion	10	0	0
38	Pastinaca sativa, L.	Wild Parsnip	10	1	10
39	Alsina Media, L.	Common Chickweed	10	4	40
40	Agrostemma githago, L.	Corn Rose	10	9	90‡
41	Malva rotundifolia L.	Common Mallow	10	2	20
42	Prunella vulgaris, L.	Self-heal	10	0	0*
43	Rudbeckia hirta, L.	Black eyed Susans	10	3	30x
44	Melilotus alba, Devs.	White Sweet Clover	10	8	80
45	Bidens frondosa, L.	Black Beggar ticks	10	0	0
46	Anthemis cotula, L.	Mayweed	10	4	40‡
47	Thlaspi arvense, L.	Field Penny-cress	10	3	30
48	Agropyron spicatum, L.	Quack Grass	10	7	70

* Secreted a jelly during germination.
‡ Quick to germinate.
x Slow to germinate.

TABLE I—*Continued.*

No.	Botanical Name.	Common Name.	No. seeds tested.	No. seeds germ.	Percentage germ.
49	Lactuca scariola, L.	Prickly Lettuce	10	2	20
50	Sisymbrium allissimum, L.	Mustard	10	4	40
51	Avena fatua, L.	Wild Oats	10	8	80
52	Helianthus annuus, L.	Sunflower	10	6	60

It will be observed in the above table that the time required in germination varies with different varieties. A number of them failed to germinate at all, but were not, however, rejected. They were retained in the experiment with the expectation that possibly after they had undergone the action of salts present in manures, they might possibly be induced to germinate.

The failure of some of the varieties may be attributed to various causes. The seeds may have been dead, the conditions may not have been favorable for their germination or the proper age for germination had not been reached. The latter is probably the most plausible as indicated by the work of Dr. W. J. Beal, Professor of Botany at the Michigan Agricultural College, in his experiment with the vitality of weed seed after being buried in the soil for different lengths of time.

Dr. Beal found that instead of a gradual decrease in the numbers of varieties that germinated as the time increased, that at the end of 25 years, one more variety germinated than at the end of 5 years.

Some of the varieties used in his work were the same as those which failed to germinate in the foregoing test. Therefore, we have reason to conclude that it is the habit of some weed seeds to remain in a dormant state for many years before germination.

It will also be noticed that the percentage of germination varies in the different varities notwithstanding the fact that the conditions of each were the same and that all of the seeds were gathered the previous fall. Dr. Beal also noticed this in his experiments, that some seeds secreted a transparent jelly-like substance which envelops the specimen, giving it somewhat the appearance of a frog's egg. This occurs only with seeds that have a hard, smooth coating.

THE EFFECT OF FERMENTING MANURE UPON THE VITALITY OF WEED SEEDS.

Three kinds of stable manure were used, namely: Horse manure, cow manure and horse and cow manure mixed in equal parts. In the meantime six bags were made from brass gauze, holding about one gallon each. These were sewed together with copper wire.

From each of the three kinds of manure samples were taken and thoroughly sterilized by boiling for at least one hour. This treatment destroyed practically all foreign seeds and fungus spores that the manure might contain. From each vessel containing the sterilized manures a sufficient quantity was drawn to fill two of the gauze bags about three-quarters full. This was in turn divided into two equal parts. Into one of these parts was put 100 seeds of each of the 52 varieties to be tested. Into the other a promiscuous number of each of the same varieties of seeds. After they were thoroughly mixed with the samples of manure, the seeds were placed into the gauze bags, the latter being sewed shut with wire. These bags were numbered A and B with lead tags, the numbers of which were stamped into the lead. No. A contained the counted seeds, and was used in the test, while No. B contained the uncounted seeds was used as a check.

The process was repeated with the sterilized samples from each kind of manure. In addition to A and B all the bags filled with the horse manure were numbered 1; those filled with cow manure No. 2, and those filled with the mixed manures No. 3. By this method of identification the pile to which the bag belonged was indicated.

The same day the manure was hauled and placed into three separate piles about 4 feet square and 4 feet high, containing about two or three tons each. The manure was tramped so as to make firm piles. The gauze bags containing the seeds were placed one foot apart about the center of their respective piles and the manure closely packed around them.

A thermometer was placed in each pile of manure so that the bulbs were between the gauze bags containing the seed and on a level with them. The readings of the thermometers were made morning and evening for 60 days. The results are compiled and shown in the following table:

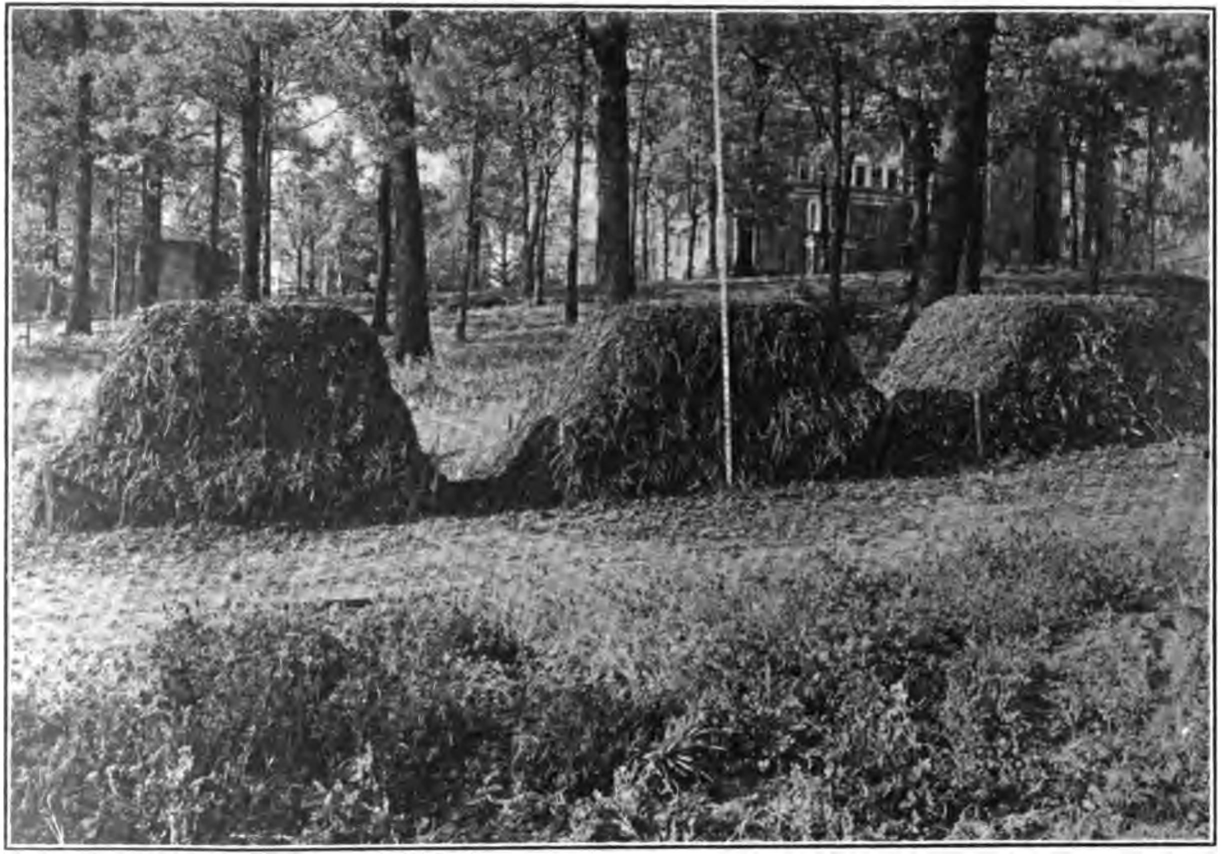

Figure 1.—The piles of manure after seeds were placed in them.

Table II. Showing the Temperatures Which Were Taken Morning and Evening from Thermometers Inserted in the Piles of Manure.

KINDS OF MANURE.	Highest temperature F.	Lowest temperature F.	Mean temperature F.
Horse manure	201°	40°	134°
Cow manure	168°	40°	120°
Horse and cow manure mixed.	188°	40°	122°
Outside the manure	………………	………………	60°

At the end of 60 days the temperature within the manure had fallen until it was about the same as that outside, and for this reason was discontinued, knowing that all of the heat had passed off.

In order to imitate as nearly as possible the conditions found in the barnyard of the average general farmers where the manure is hauled out but twice a year the seeds were allowed to remain in the piles for 6 months.

The method adopted in testing the vitality of the seeds after they had passed through the fermentation in the piles of manure was as follows: First, in order to secure accurate results, it was essential that the seeds be planted in soil that was free from weed seeds. This was procured by sterilizing the soil. That used was a good grade of potting soil sterilized by two different methods. First, by live steam, in which the soil was placed in a barrel through which a steam pipe was inserted and the steam allowed to escape at the bottom of the barrel. The soil was mixed with water until about the consistency of mortar. The steam was then turned in and the mass allowed to boil for more than two hours. The other method employed was dry sterilization, in which the soil is baked in the oven of a kitchen range in pans for 3 hours.

In a preliminary test of the two methods it was found that sterilization in the former case was insufficient, owing to the fact that a number of varieities of weed seeds found in the soil still continued to grow after the soil had been boiled. The soil sterilized by the dry method was found to be free from seeds having any vitality whatever.

The bench of the greenhouse was next divided into 6 equal parts: each part being about 12 inches by 36 inches. These sections were filled with soil sterilized by the dry method to a depth of one inch and numbered corresponding to the numbers on the gauze bags which contained the seeds.

The gauze bags were opened and the contents taken from each one and scattered evenly over the corresponding part of the bench. Over this a thin layer of sterile soil was sprinkled, just enough to cover the seeds and prevent their being exposed.

These plots were kept watered and given careful attention. After a reasonable length of time they were examined and without a single exception all of the seeds failed to germinate. The seeds that could be found were easily crushed between the fingers, thus showing that they had rotted and their vitality was destroyed.

EFFECT OF PARTIALLY FERMENTED MANURE ON THE VITALITY OF WEED SEEDS.

The work so far gives results based on the general farmer's method of caring for manure. In order to cover the conditions usually followed by dairymen and gardeners, where the manure remains in piles only for a short time, another set of experiments were started the same fall. These were conducted in exactly the same manner as was the former test, excepting that the seeds were allowed to remain in the pile a shorter time. The second lot remained in the manure for only one month, after which they were taken from the piles and placed over sterilized soil on the greenhouse bench exactly the same as the seeds were in the former experiments, and they received the same attention.

After a reasonable length of time the plots were examined and the results found were synonomous with those of the plots in the previous experiment, except that some of the seeds found were still firm and would not crush when pressed between the fingers. They were the following varieties:

Plantago lancealata, L.
Rib Grass.
Slanum carolineuse, L.
Horsenettle.
Plantago major, L.
Common Plantain.
Ambrosia trifida, L.
Large Ragweed.
Rumex obtusifolius, L.
Bitter Dock.
Malva rotundifolia, L.
Mallow.

THE EFFECT OF PASSING GRAIN AND WEED SEED THROUGH THE DIGESTIVE CHANNEL OF DOMESTIC ANIMALS UPON THEIR VITALITY

So far we have dealt with the effect of manure upon the vitality of weed seeds as influencing their distribution. From the table of results in the first part we find that no seeds whatever grew after they were taken from the manure piles, this leading us to conclude that the heat and chemical action which took place under fermentation had a devitalizing effect on weed seeds, and that little danger of bringing noxious weeds from one locality to another would be incurred by the use of manure that had remained in piles for one month or more.

To answer questions from those who do not allow the manure to rot in piles but haul it directly from the stable to the field, or those who allow their farm animals to graze in the fields and the droppings to remain wherever they chance to fall, it is necessary to deal with the effects of digestive fluids upon the vitality of seeds. Accordingly the following experiments were conducted. They were arranged so as to meet every possible condition.

The importance of this phase of the work was especially emphasized by the inquiries of the consumers of Sucrene and molasses feeds as well as the manufacturers of the same, whose desire it was to learn whether it was possible to introduce seeds through the use of these feeds. Their inquiry was probably based on statements made by the Vermont Agricultural Experiment Station in their bulletin No. 131 on "Commercial Feeding Stuffs." As a result of the investigation described in this bulletin it was found that many of the commercial feed stuffs contained a large number of noxious weed seeds. Some brands of molasses feeds sold as dairy feed were reported to contain as many as 129,000,000 weed seeds to a ton.

Even though these feeds contain large numbers of weed seeds we would not be justified in concluding that all of them will pass through the animal and still retain their average degree of vitality, as they are in a large measure liable to injury by being crushed between the teeth of the feeding stock and by the action of the digestive juices.

The first step taken in this experiment was to procure a number of the worst and most common weed seeds in Maryland and those most often found in hays and commercial feeds. A number of common grains and grasses were also used.

A sample of 50 seeds was taken from every variety of seeds to be used in this experiment, and these 50 seeds were tested for their vitality so as to ascertain the percentage of germination of each variety. The germination test was conducted exactly in the same manner as it was with the seeds used in the test under fermenting manure conditions.

For the sake of convenience these seeds were divided into three lots and numbered 1, 2, 3, respectively, as seen by the tables. The result of the germination test was kept in tabulated form, as will be seen from the appended tables Nos. 3, 4, 5.

Table III. Showing Result of Germination Test of Lot No. 1.

No.	Botanical name.	Common name.	No. seeds tested.	No. seeds germi.	Per-centage germi.	Remarks.
1	Agrostis alba, L.	Red top	50	40	80	
2	Avena sativa	Oats	50	40	80	
3	Hordeum vulgare	Barley	50	50	100	All strong.
4	Poe pratensis, L.	Blue grass	50	15	30	Poor germination.
5	Secale calecer, L.	Rye	50	30	60	2 strong, 4 weak.
6	Symtherisma fimbriata, Nash.	Crab grass	50	40	80	
7	Trifolium incarnatum L.	Crimson clover	50	35	70	
8	Trifolium pratense, L.	Red Clover	50	30	60	
9	Trifolium repens, L.	White clover	50	45	90	
10	Triticum, vulgare	Wheat	50	50	100	All strong.
11	Vicia hirsuta, L.	Hairy vetch	50	25	50	2 strong, 3 weak.
12	Zea Maize	Corn	50	50	100	All strong.
	Total......................		600	450	75	

Table IV. Showing Result of Germination Test of Lot No. 2.

No.	Botanical Name.	Common Name.	No. of seeds tested.	Total Number grew.	Percentage grew.	REMARKS.
1	Agrostemma Githago, L.	Cockle	50	30	60	
2	Ambrosia artemsiaefolia, L.	Rag Weed	50	2	4	Weak germination.
3	Bidens bipemata, L.	Spanish needles	50	00	00	No germination.
4	Datura Stramonium, L.	Jamestown weed	50	20	40	Quick to Germinate.
5	Ipomoea hederacea, Jocq.	Morning glory	50	10	20	
6	Lepidium campestre, L.	Pepper weed	50	25	50	Slow to germinate.
7	Malva rotunbofolia, L.	Mallow or velvet leaf	50	15	30	Quick to germinate.
8	Polygonum Hydropiper, L.	Smart Weed	50	4	8	
9	Rumex altissimus, Wood	Narrow Dock	50	10	20	
10	Sisymbrium allissinum, L.	Wild mustard	50	20	40	
11	Solanum carolineus, L.	Horse nettle	50	15	30	Slow to germinate.
	Total..........		559	151	27.4	

Table V. Showing Result of Germination Test of Lot No. 3.

No.	Botanical Name.	Common Name.	No. of seeds tested.	No, seeds grew.	Per-centage grew.	REMARKS.
1	Agrostemma Githago, L.	Corn Rose	50	45	90	Quick to germinate.
2	Alsine media, L.	Common Chickweed	50	15	30	
3	Amaranthus retroflexus, L.	Rough Pigweed	50	10	20	Slow to germinate.
4	Avena fatua, L.	Wild Oats	50	40	80	
5	Bromus secalinus, L.	Cheat	50	25	50	
6	Chaetocheoa glauca, L.	Pigeon Grass	50	30	60	Quick to germinate.
7	Cuscuta Byrich arvensis,	Field Dodder	50	35	70	
8	Cuscuta Epithymum, Murr.	Clover Dodder	50	35	70	
9	Datura tatula, L.	Purple Thorn Apple	50	10	20	Slow to germinate.
10	Medicago lupulina, L.	Black Medick	50	25	50	
11	Melilotus alba, Devs.	White Clover	50	40	80	
12	Plantago lancealata, L.	Rib Grass	50	15	30	Jelly secreted before germination starts
13	Rudbeckia hirta, L.	Black-eyed Susan	50	10	20	Slow to germinate.

TABLE V.—*Continued.*

No.	Botanical Name.	Common Name.	No. of seeds tested.	No. seeds grew.	Per-centage grew.	REMARKS.
14	Rumex obtusifolius, L.	Bitter Dock	50	50	100	Slow to germinate.
15	Solanum nigrum, L.	Common Nightshade	50	20	40	
	Total............	....	750	405	54	

To facilitate the keeping of an accurate record 2000 seeds were counted from each variety, this being considered large enough number to give an accurate result.

METHODS USED IN FEEDING OF THE SEEDS.

The animals chosen in this work were three healthy yearling calves, yearlings being chosen because their digestive organs were about of an average strength as based on the young calf and the old mature animal. These three calves were numbered 1, 2, 3, to correspond with the numbers given to the groups into which the seeds divided. They were placed in separate stalls with cement floors, so that the manure from each one could be kept separate.

A balanced ration of wheat bran, gluten meal, malt sprouts and cut corn fodder was prepared and fed twice a day, morning and evening. The object in using the above ration was to be free from having any weed seeds in the feed other than those fed in the experiment and of which a record was kept. To be sure the digestive tract of the animals was free from weed seeds, the calves were fed a preliminary feed of the balanced ration four days before the test began.

On the fifth day a portion of each group of seeds was mixed with the ration and fed to the calf correspondingly numbered. The seeds were fed for four days, the total number being distributed equally between each feed. After the second day, or after the fourth feed, the manure from each calf was saved separately for five days, which ran it three days longer than the feeding of the seeds was continued. This was done to be sure that every seed would have time to pass through the animal's body. No bedding was used under the calves in order to prevent the introduction of any foreign weed through the bedding and at the same time to keep the bulk of manure small.

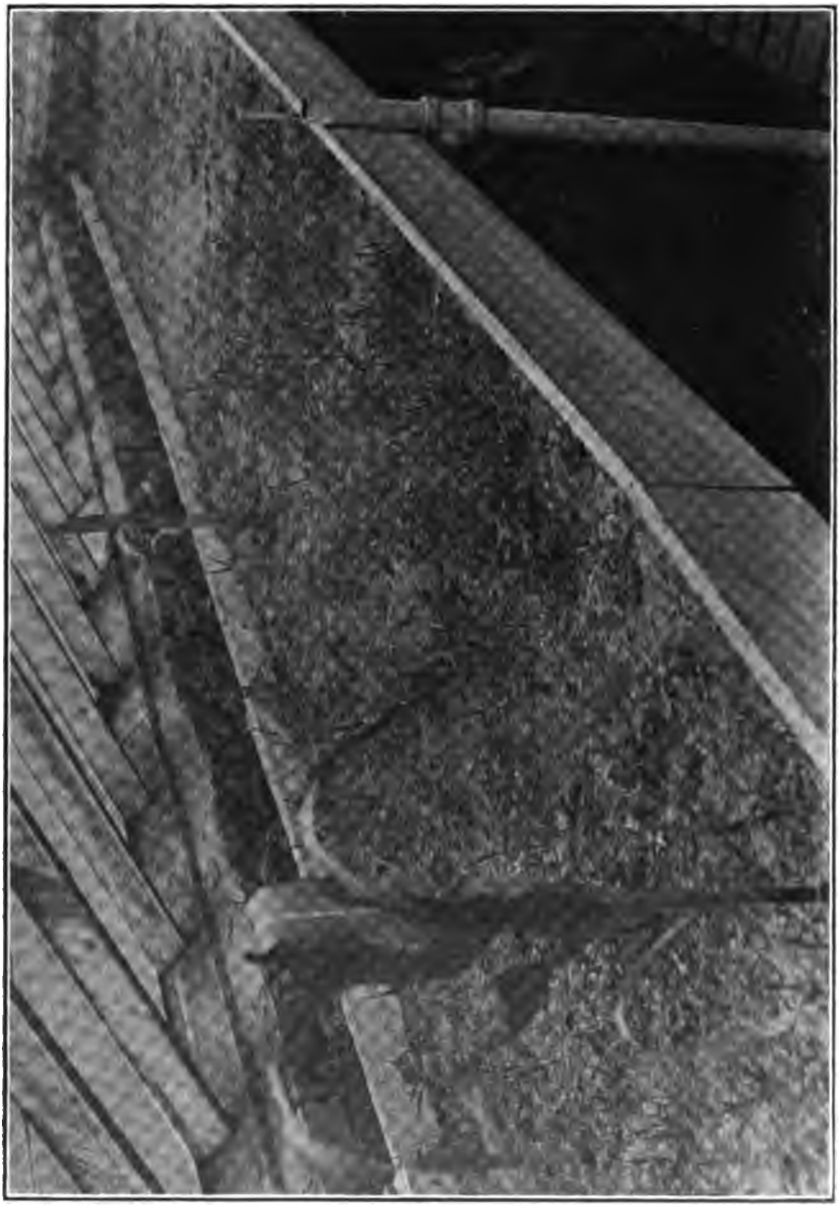

Figure 2.—Plot 1 A., showing the growth of some grain seeds one month after planting.

CONDITIONS SIMILAR TO THE PRACTICE OF TOP DRESSING WITH FRESH MANURE.

Each day as the manure was separately and carefully collected into tubs numbered 1A and 2A it was washed through a series of sieves which allowed the soluble parts to pass out and retained the crude fiber and seeds on the sieves. This material was then spread ½ inch thick on the greenhouse bench over about one inch of sterile soil, sterilized by the baking process to make sure that all the seeds were killed. The benches were numbered 1A to 2A. Over this manure a thin layer of sterilized soil was spread to prevent the seeds from undue exposure.

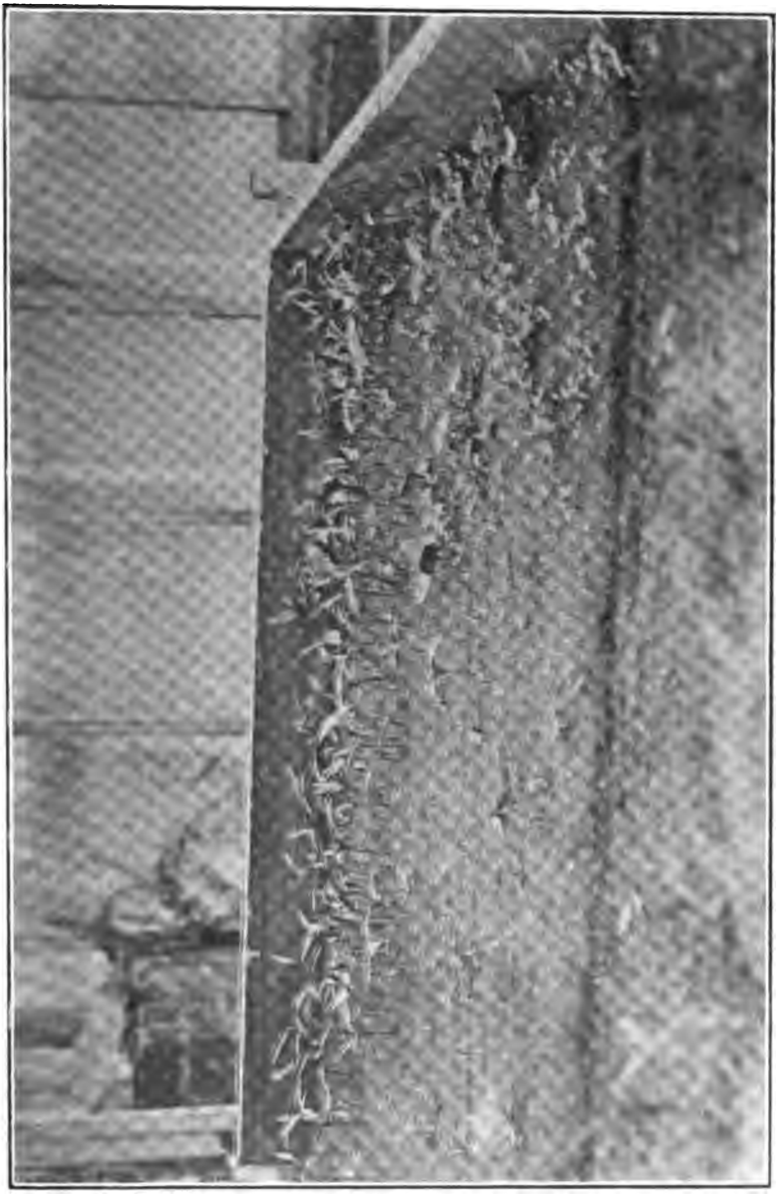

Figure 3.—Plot 2 A., showing the growth of some weed seeds fed in feed one month after planting.

Table VI. Showing Result After the Seeds Have Been Fed to Animals and the Manure Spread Over Sterile Soil. No. 1A. Manure Was Washed Through Sieves to Take Out Soluble Parts.

No.	Botanical Name.	Common Name.	No. of seeds fed.	No. that grew.	Percentage germi.	Remarks.
1	Tricicum vulgare	Wheat	2000	174	8.7	
2	Syntherisma fimbriata, Nash.	Crab grass	800	319	37	Vitality excellent.
3	Scale cereale, L.	Rye	1200	30	2 5	
4	Zea Maize	Corn	2000	4	.02	Germination retarded.
5	Hordeum vulgare	Barley	2000	20	1	Weak germination.
6	Avena sativa	Oats	1600	4	.25	Weak germination.
7	Agrostis alba, L.	Red top	1600	320	20	
8	Poa pratensis, L.	Blue grass	600	80	13	
9	Vicia hirsuta, L.	Hairy vetch	1000	110	24 6	Germination retarded.
10	Trifolium pratense, L.	Red clover	1200	36	3	Weak germination.
11	Trifolium repense, L.	White clover	1800	18	1	
	Total....		15800	1115	7.05	

Table VII. Showing the Result After the Seeds Were Fed to Animals and the Manure Spread Over Sterile Soil. No. 2A. Manure Was Washed Through Sieves to Take Out Soluble Parts.

No.	Botanical Name	Common Name.	No. of seeds fed	No. that grew	Percent grew	Remarks.
1	Malva rotundifolia, L.	Mallow Velvet leaf	600	60	10	Quick to germinate
2	Datura Stramonium, L.	Jamestown Weed	800	572	71.5	Quick to germinate
3	Ambrosia, artemsiaefolia, L.	Ragweed	80	52	65	
4	Rumex altissimus, wood.	Narrow Dock	400	60	15	
5	Agrostemma Githago, L.	Cockle	1200	10	8	
6	Sisymbrium allessirnum, L.	Wild Mustard	800	80	10	
7	Lepidium compestre, L.	Pepperweed	1000	10	1	Slow to germinate
8	Polyganum Hydropiper, L.	Smart weed	320	32	10	
9	Impoea hederacea, Jocq.	Morning Glory	400	4	1	
10	Solanum carolineus, L.	Horsenettle	600	740	123	Slow to germinate
11	Bidens bipennata, L.	Spanish needles	....	....	....	
	Total		6200	1620	26.1	
	Totals (tables 6 and 7)........		22000	2735	12.8	

CONDITIONS SIMILAR TO THE PLOWING UNDER OF FRESH MANURE.

The manure from calf No. 3 was not passed through sieves but put directly in a similarly prepared bench in the greenhouse and covered to a depth of ½ inch and thoroughly mixed with the sterile soil contained on the bench. In practice of plowing the manure under of course it would be covered to a greater depth, but, all things considered, it was thought best to limit the depth in this test.

Each day as the manure was collected it was placed and treated as described. At the end of the fifth day the calves were free from the experiment and the manure saving was discontinued.

Table VIII. Showing Result After Seeds Were Fed to Animals and the Manure Spread ½ inch Thick Over Sterile Soil. No. 3A.

Manure Mixed With Sterile Soil.

No.	Botanical Name	Common Name	No. of seeds fed.	No. seeds grew.	Percentage grew.	REMARKS.
1	Rumex obtusifolius, L.	Bitter Dock	1000	26	2.6	Majority weak.
2	Plantago lancalata, L.	Rib Grass	300	25	8.3	Wilted away.
3	Amaranthus retroflexus, L.	Rough Pigweed	200	12	6	
4	Chaetocheoa glauca, L.	Pigeon Grass	600	50	8.3	Some wilted.
5	Alsine media, L.	Common Chickweed	300	11	3.6	
6	Agrostemma Githago, L.	Corn Rose	900	38	4.2	
7	Medicago lupulina, L.	Black Medick	500	5	1	
8	Cuscuta arvensis, Byrich	Field Dodder	700	18	2.5	

TABLE VIII.—*Continued.*

No.	Botanical Name	Common Name	No. seeds fed.	No. seeds grew.	Per-centage grew.	REMARKS.
9	**Melilotus alba, Devs,**	**White Sweet Clover**	**800**	**6**	**.75**	
10	**Cuscuta epithymum, Murr.**	**Clover Dodder**	**700**	**7**	....	
11	**Avena fatua, L.**	**Wild Oats**	**800**	....	....	
12	**Rudbeckia hirta, L.**	**Black-eyed Susan**	**200**	....	....	
13	**Bromus recalinus, L.**	**Cheat**	**500**	....	....	
14	**Datura tatula, L.**	**Purple Thorn Apple**	**200**	....	....	
15	**Solanum nigrum, L.**	**Common Nightshade**	**400**	....	....	
	Total............	....	8100	198	2.3	

CONDITIONS SIMILAR TO PASTURING CATTLE ON FIELDS.

So far the work done had only taken up conditions suited to the hauling of the manure direct upon the field. Numbers 1A and 2A were given about the same conditions as the manure that is placed on the field as a top dressing and exposed to rains which washes out the soluble parts to a greater or less degree. Number 3A fulfills as nearly as possible the conditions where the manure is harrowed directly into the soil or plowed under.

To bring about the conditions when the cattle graze on the fields two of the three calves used at first were placed under the same environments as before, and fed exactly the same preliminary ration. This time they were numbered 1B and 2B, and were fed the same quantity and kind of seeds and cared for in the same manner as before.

Instead of washing the manure through sieves, as in the experiment with 1A and 2A, it was placed directly over the sterile soil in the greenhouse bench to a depth of ½ inch. It was not mixed with the soil at all this time, nor was it even covered with a thin layer of soil. The object of this omission was to bring about conditions analagous to those where the manure is dropped unadulterated in the pasture fields.

Table IX. Showing the Result After Seeds Were Fed to Animals and the Manure Spread ½ inch Thick Over Sterile Soil. No 1B.

No.	Botanical Name.	Common Name	No. seeds fed	No. that grew.	Percentage germi.	Remarks.
1	**Syntherisma fimbriata, Nash**	**Crab grass**	800	160	20	**Vilality good.**
2	**Triticum vulgare**	**Wheat**	2000	12	.6	**Some wilted.**
3	**Secale cereale, L.**	**Rye**	1200	12	.6	**Wilted away.**
4	**Zea Maize**	**Corn**	2000	1	.05	**Wilted away.**
5	**Vicia hirsuta, L.**	**Hairy Vetch**	1000	20	2	**Some wilted.**
6	**Agrostemma alba, L.**	**Red top**	1600	17	1.06	
7	**Poa pratensis, L.**	**Blue Grass**	600	6	1	
8	**Hordeum vulgare**	**Barley**	2000			
9	**Avena satilva**	**Oats**	1600			
10	**Trifolium repens, L.**	**White Clover**	1800			
11	**Trifolium pratensis, L.**	**Red Clover**	1200			
12	**Trifolium Incarnatum, L.**	**Crimson Clover**	1400			
	Total..........	**............**	17200	228	1.33	

Table X. Showing Result After Seeds Were Fed to Animals and the Manure Spread 1-2 Inch Thick Over Sterile Soils, No. 2 B.

No.	Botanical Name	Common Name	No. of seeds fed	No. that grew	Percentage grew	Remarks.
1	**Malva rotundifolia, L.**	**Mallow Velvet leaf**	600	8	1.3	
2	**Datura stramonium, L.**	**Jamestown Weed**	800	136	17	Plants strong.
3	**Ambrosia artemsiaefolia, L.**	**Rag Weed**	80	4	5	T.
4	**Solanum carolineus, L.**	**Horse Nettle**	600	320	53	Germination good.
5	**Rumex altissimus, wood.**	**Narrow Dock**	400	10	2.5	
6	**Agrostemma Githago, L.**	**Cockles**	1200	6	.5	Germination poor.
7	**Sisymbrium allissirnum, L.**	**Wild Mustard**	800	12	1.5	
8	**Polygonum Hydropiper, L.**	**Smart Weed**	320	24	7.5	Plants strong.
9	**Lepidium campestre, L.**	**Pepper Weed**	1000			
10	**Ipomoea hederacea, Jocq.**	**Morning Glory**	400			
11	**Bidens bipennata, L.**	**Spanish Needles**				
	Total,..........	....	6200	520	8.2	
	Totals for tables 9 and 10....		23400	748	3.1	

The experimental plots were watered and cared for to the best advantage and notes were taken from day to day. Numbers 1A and 2A began to show evidence of growth in a very few days, and in a week's time the little plants were seen pushing their way through the washed manure. In plot 1A wheat, crab grass and rye were the first to come up and the rest followed in order as found in table 6. In plot 2A Velvet leaf and Jamestown weed were the first to appear and the rest appeared according to order in the table 7. On the whole, the growth was very irregular and some did not start to grow until the fifth week.

Numbers 1B, 2B and 3A showed no signs of growth whatever until the beginning of the third week, at which time they began to appear in about the same order as before, only they were much slower and much more irregular in doing so. Fewer of them grew, and though in some of the varieties a few plants made their appearance early but soon withered away and no more came until much later, when a considerable number started to grow and did well.

The foregoing tables give tabulated results with remarks when necessary. The results were compiled from the notes that were taken daily during a period of 60 days from the time when the manure was placed in the greenhouse.

In the tables numbered with figures and letters it will be observed that the numbers placed in the column headed, No. seeds fed, are very irregular. This is due to the fact that these numbers are based on the percentage of germination as found and shown in tables 3, 4 and 5. Two thousand seeds were fed in each case, but it is only right that we should consider the number that would have grown had they been planted under ordinary circumstances.

Should it appear in the table that more grew than was fed to the animal in the beginning, we must stop to consider that the number fed in the column so marked is based on the percentage of germination, and must conclude that the digestion exerted a favorable influence on the germination of that particular variety by causing more of them to germinate than would otherwise have germinated had the seeds been planted before passing through the body of an animal.

SUMMARY.

The above results were obtained through experiments concerning the vitality of weed seeds under the influence of their distribution by manure along two different lines; namely, the effect of fermenting manure on the vitality of weed seeds (seeds introduced through bedding), and the effect upon the vitality of weed seeds after passing through the digestive channel of domestic animals (seeds fed to animals).

The first part of the experiment was accomplished so as to cover the condition where manure remains for 6 months in a barnyard pound or pile. The second covered conditions where the manure remained on piles for a short while, as when shipped by carload lots from cities.

From the above results the following conclusions seem justified:

1st. When manure is allowed to ferment in piles for 6 months no danger of distributing weed seeds is incurred.

2nd. When manure is allowed to remain in piles and undergoing partial fermentation, little danger of distribution is incurred.

The second part of the experiment which dealt with the effect upon the vitality of weed seeds after passing through the digestive channels of domestic animals was accomplished so as to bring about three existing conditions.

1st. Manure hauled direct from the stable to the field as a top dressing and left there exposed to the washing of the rains.

2nd. Where the manure is hauled directly from the stable to the field where it is immediately plowed under.

3rd. Where the domestic animals are allowed to run in the pasture and the droppings are allowed to remain wherever they chance to fall.

From the above tables in the latter part the following results were obtained:

1st. Where the manure was hauled directly from the stable as a top dressing an average of only 12.8' per cent of the seeds fed to animals germinated. (See tables 6 and 7.)

2nd. Where manure was hauled directly from the stable upon the land and plowed under 2.3 per cent of the seeds fed to animals came up. (See table 8.)

3rd. Where the droppings remained on the pasture fields unadulterated as they fell an average of only 3.1 per cent of the seeds fed to animals germinated. (See tables 9 and 10.)

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OF THE

Maryland Agricultural Experiment Station.

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" "	**58, Aug.,**	**1898,**	**The Hessian Fly and Wheat Diseases.**
" "	**61, June,**	**1899,**	**The Sugar Beet in Maryland.**
" "	**63, Dec.,**	**1904,**	**Pig Feeding.**
" "	**71, Feb.,**	**1901,**	**Notes on Spraying Peaches and Plums in 1900.**
" "	**72, March,**	**1901,**	**Observations on Growing Peaches in Maryland.**
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" "	**93, May,**	**1904,**	**Second Report on the Pithiness of Celery.**
" "	**96, Sept.,**	**1904,**	**Sweet Corn Breeding, Growing and Curing for Seed.**
" "	**97, Oct.,**	**1904,**	**The Relative Profits of Selling Milk, Cream and Butter.**
" "	**101, April,**	**1905,**	**Common Injurious and Beneficial Insects.**
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" "	**115, Feb.,**	**1907,**	**Control of Insect Pests and Diseases of Maryland Crops.**
" "	**116, March,**	**1907,**	**Marketing Fruit and Truck Crops.**
" "	**117, April,**	**1907,**	**Molasses Feeds.**
" "	**118, June,**	**1907,**	**Alfalfa in Maryland.**
" "	**119, July,**	**1907,**	**Greenhouse Pests in Maryland.**
" "	**120, Aug.,**	**1907,**	**Sweet Corn Investigation.**
" "	**121, Sept.**	**1907,**	**Beef Cattle Industry of Maryland.**
" "	**122, Oct.,**	**1907,**	**Stable Manure Experiments.**
" "	**123, Nov.,**	**1907,**	**The San Jose Scale and the Peach Lecanium.**
" "	**124, Dec.,**	**1907**	**Strawberries.**
" "	**125, Feb.,**	**1908,**	**Nut Growing in Maryland.**
" "	**126, April,**	**1908,**	**Manuring and Fertilizing Truck Crops.**
" "	**127, May,**	**1908,**	**Miscellaneous Greenhouse Notes.**
" "	128, June,	1908,	The Effect of Animal Digestion and Fermentation of Manure on the Vitality of Seeds.

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The
Twenty-second
Annual Report

VOLUME No. 22
OF THE
Maryland Agricultural Experiment Station
COLLEGE PARK, MD.
1908-1909

The Maryland Agricultural Experiment Station

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*On State Horticultural Department Work.

The Station is located on the B. & O. R. R. and City and Suburban Electric Car Line, eight miles north of Washington, D. C. Bell Telephone, Hyattsville 55 R.

Visitors will be welcomed at all times, and will be given every opportunity to inspect the work of the Station in all of its departments.

The Bulletins and Reports of the Station will be mailed regularly, free of charge, to all residents of the State who request it.

Address

AGRICULTURAL EXPERIMENT STATION
College Park, Maryland

THE TWENTY-SECOND

ANNUAL REPORT

OF THE

MARYLAND AGRICULTURAL EXPERIMENT STATION

COLLEGE PARK
PRINCE GEORGE'S CO., MARYLAND

1908-1909

PUBLISHED BY THE STATION

LETTER OF TRANSMITTAL

To His Excellency, Austin L. Crothers, Governor, and President of the Board of Trustees, Annapolis, Maryland.

SIR: In accordance with the provisions of Section No. 3 of the Act of Congress, approved March 2, 1887, "To Establish Agricultural Experiment Stations," etc., I have the honor to transmit the Twenty-second Annual Report of the Maryland Experiment Station for the fiscal year ending June 30, 1909.

Very respectfully yours,

H. J. PATTERSON,

Director of the Experiment Station.

July, 1909.

THE MARYLAND

Agricultural Experiment Station

VOLUME 22 1908-1909

Report on the Work and Expenditures of the Maryland Agricultural Experiment Station and Recommendation for Enlarging its Sphere of Usefulness

For the Year Ending June 30, 1909

By H. J. PATTERSON, Director.

To the Honorable Board of Trustees of the Maryland Agricultural Experiment Station.

GENTLEMEN: I have the honor to submit herewith for your consideration some recommendations for enlarging the work of this institution so as to enable it to meet the demands already made upon it by the farmers of the state, and at the same time to cause this institution to become a great factor in developing Maryland's agricultural possibilities.

The present state administration and its Chief Executive, Governor Crothers, will ever be remembered for the position which has been taken to give this state *Good Roads*. There is nothing which could have been done that would do so much towards advancing the financial, educational, social and spiritual interests of the people. The next great step which can be taken, and which will make another epoch in our state's progress, is to develop and conserve our natural resources. The greatest natural resource in this state is unquestionably the soil. The development of this resource will be of inestimable value in increasing the revenues of this state, and in promoting the happiness of our people. I believe that the Maryland Agricultural College and Experiment Station, when fully equipped, can be a *great factor* for developing and conserving the agricultural resources of the state, and that a great opportunity rests with this Board of Trustees and the present State Administration to set on foot an active movement to this end. The expense involved in such a project will necessarily be large, but when all things are considered the total amount will be but a bagatelle when measured by the results attained. The guiding thought for the Board of Trustees of this institution, which is ex-officio the State Board of Agriculture, should be, not how little money you can exist on, but how much can be spent with profit to the industry and the people you represent. I believe that I am close enough to the farmers of this state to feel confident that such a policy will meet with their approval, even though it necessitated slightly increasing their taxes.

WORK OF THE INSTITUTION UNDER THE BOARD OF TRUSTEES

The work assigned to this Board of Trustees may be properly divided into five classes, viz:

1. Research or investigational work.
2. Demonstration work.
3. Extension or Farmers' Institute work.
4. Educational or school and college work.
5. Police control or inspection work.

There are certain phases of all of these lines of work that are distinct and must be conducted independently; but for the full development of all of them, so as to get the greatest benefits, they will necessarily overlap and consequenty should be developed coördinately and simultaneously.

The work of this institution should be regarded as a business or commercial proposition, and the people and their representatives should treat it on the same basis as a corporation and the directors of a corporation would treat a business proposition—for the state is really a big corporation of which the people are the stockholders.

RECOMMENDATIONS

In order to develop this institution in harmony with these ideas, I submit the following recommendations, and in doing so will state that I have no desire to trespass on the rights of other Departments, but only submit ideas which it would seem to me to be necessary for our mutual development. Most of these ideas, at the solicitation of the President of the College, have been presented to the farmers' organizations of the state and have been endorsed by them.

QUALITY OF INVESTIGATORS AND TEACHERS

In order that investigations of a high character may be conducted, and students and farmers have confidence in their instructors, it is very desirable, and I believe essential, that the work be done by thoroughly trained specialists.

Such men are scarce in every line of agriculture, hence much in demand, and they are commanding higher wages than is paid for teachers and investigators in many other fields.

The day for the general teacher in agriculture has past and those institutions which are keeping pace with the demands upon them are having their men specialize more and more.

For the gricultural and technical schools to follow such a course is only to do what the medical and law schools have been doing for many years.

I believe it is the exception, rather than the rule, to find men who are equally good as teachers and investigators, and I believe it is not for the best interest of the work to expect men to divide up their energies constantly. A man should be either mainly an investigator or a teacher, but for his own welfare, as well as the best interests of the institution, he should not wholly exclude the other. I believe every good teacher should be pursuing some investigation which he can follow at odd times, and I also believe that every investigator should give a course of lectures or instruction (possibly in some cases only one) to students, as this will enable him to collect his ideas and results and crystallize them into some tangible form. The agricultural investigator should also attend some farmers' meetings and visit some of the best farmers in his line, so as to keep him in touch with what the farmers are thinking about, see things from their point of view, and thus enable him to adjust his investigations accordingly. This teaching and institute work should be given, however, connectedly, and in a few days or weeks, so as not to be continually interrupting the investigations. This plan enables the heavy teaching work to be done by men who have that as their principal business, but it also enables farmers and students to be instructed by specialists in every sphere of agriculture.

The plan of thoroughly equipping the institution with a full corps of specialists will enable any student who desires to prepare to follow any specialty in farming to get instruction by a specialist and expert. This plan also would enable every farmer to consult such men when seeking advice and help.

SOIL FERTILITY

The fertility of the soil is the foundation of all successful agriculture, and while it is the oldest subject under consideration of the investigator, yet many questions remain unsolved and this station should considerably broaden and extend its investigations on increasing and conserving fertility and adapt them to all types of soils. The points that would seem to require immediate attention are as follows:

1. The rendering of plant foods available on different types of soils through crops and indirect fertilizers.
2. How crops should be used for increasing and conserving soil fertility.
3. The rate of diffusion and of depletion of lime and other alkalies in different types of soils.
4. The limits of profit in the use of relative amounts of plant foods in commercial fertilizers when applied to different types of soils.

Much demonstration and extension work on the question of soil fertility should be done so as to induce the mass of the farmers to practice better methods.

This subject is of sufficient importance to warrant the expenditure of many times as much as is now available for the work.

Crop Production

The station has already done considerable work on crop production, and we have at the present time two men devoted to this work, but when the acreage and annual value of the principal crops are considered I believe we would in reality be justified in having almost a man for each crop.

The total annual value of the products of Maryland farms is nearly 45 millions of dollars.

Maryland devotes to:

Crop	*Acres*	*Annual value of crop*
Corn	658,000	7½ millions of dollars.
Wheat	640,000	6½ " " "
Hay crops	425,000	5 " " "
Rye, Barley, Oats, Buckwheat, etc	100,000	1½ " " "
Tobacco	50,000	1½ " " "

When we consider the annual income that is derived from any one of the products that has been enumerated and then look at the average yields and how much these yields fall below what the most successful farmer gets, and what should be obtained to make the business profitable, we come to appreciate that investigations should be conducted which will locate the difficulties and determine the remedies. Such investigations should be conducted by the best talent that can be procured, and I am sure that a careful consideration of the subject would convince all, that every crop is of sufficient importance in our state to justify the employment of a specialist for investigating, demonstrating and teaching them.

To illustrate more in detail the commercial side of this question, or in other words reduce it to a business proposition, take the corn crop for example: The present average yield is only 30 bushels per acre, while good farmers get 50 to 75 bushels per acre. It has been demonstrated by investigations that the proper selecton of seed alone would increase the yield 2 barrels, or ten bushels, per acre, and this at this year's prices would have given Maryland farmers over three millions more dollars for their corn crop. I believe that by the expenditure of $5,000 to $10,000 per year in corn investigations and demonstrations alone, for five years, that the average yield of corn can be increased so that the annual revenue from this crop will be from two to five millions of dollars more than at present. Surely this is a business proposition which no corporation would turn down; then why should the people of the state? What can be done with corn can be accomplished on the same relative scale with the other crops.

ANIMAL INDUSTRY

Maryland devotes to:

Animal Products	*Capital Invested*	*Annual Production*
Horses	10 millions of dollars	2 millions of dollars.
Dairy cattle	4¾ " " "	5¼ " " "
Beef and miscellaneous cattle	2 " " "	
Hogs	1 " " "	4¾ " " "
Sheep	¾ " " "	
Poultry	¾ " " "	3½ " " "
Bees	⅛ " " "	40 thousand dollars.

The amount invested and the annual income from the animal products are much more than most people suppose, as the above figures will indicate.

The annual loss of animals through death is very great and much of this could be prevented by the proper use of immunizing serums.

The state should have a laboratory for the preparation of these materials so that the people of the state could avail of them at a nominal cost.

It is a rare thing to find a man who is an expert, or a successful breeder of all classes of animals. The dairy-man usually knows but little about horses, or sheep, and vice versa. Then why should we expect the best investigations or instruction to be given by a man who has to work with all classes. Surely the amount invested, the annual income, and the improvements which should be accomplished would justify having an expert in each class.

HORTICULTURAL WORK

The work in all departments of our institution should be placed on a high plane and the various departments well equipped so as to enable them to do thorough work; but natural conditions are such that this institution should aim to make its horticultural department particularly strong and build up a national, if not a worldwide, reputation for this phase of the work of the institution and the state. Because of our location, near Washington, and the wide range of horticultural possibilities in the state, this ambition for our institution is not too much to hope for, and I am sure is possible, but the opportunity is now ripe and if we are to compete for this prize we must act at once. Every university and experiment station of much note has made its chief reputation for some one or two things and I have been convinced for years that we should develop our horticultural work so as to make it second to none in the United States.

To do this effectually would require considerably more of an equipment than we have at present, and would necessitate having specialists in Pomology, Small fruits, Market garden crops, Floral culture, Greenhouse crops, Landscape gardening and Forestry.

The full development of the horticultural possibilities of Maryland, I am sure, would justify the expenditure of from 40 to 75 thousand dollars for a building and equipment, besides sufficient funds for maintaining the several departments enumerated.

Maryland devotes to:

Crop	*Acres*	*Annual value of crop*
Vegetables and flowers......................	100,000	4 millions of dollars.
Potatoes..................................	40,000	1¼ " " "
Orchard fruits............................		1½ " " "
Small fruits..............................		1¼ " " "

RURAL ENGINEERING, FARM ARCHITECTURE AND FARM MECHANICS

This state, and in fact the country as a whole, is very much in need of men trained especially as rural engineers, rural architects and in farm mechanics, and none of our institutions are instructing, demonstrating and investigating these questions as they should do.

We have nearly 400,000 acres of land in Maryland that is nearly worthless for the want of drainage that could be made very profitable for agricultural purposes if drained. Nearly 50 per cent of our farms have some lands on them which should be drained. The healthfulness of the state alone would justify the drainage of these lands, to say nothing of the increased agricultural value. Much money is now wasted by improper drainage and many hesitate to undertake the drainage of land for fear of failure because of insufficient knowledge.

Drainage should e investigated, demonstrated and taught by a skilled engineer who has had practical experience. It is not sufficient to simply know how to run a level.

Instruction in the building of country roads should be given by one who has had practical experience in such work. It is not sufficient to look at highways from the standpoint of railroad construction. Every community would be benefited if they could obtain just as good specifications for the proper practical expenditure of money on roads, whether they had only $25 per mile as when they have from $1,000 to $10,000 per mile.

Most farms could be much improved and labor saved by properly laying them out so as to have the fields conform to soil types, and the roads and buildings adjusted to the crop production.

There is a great need for training in the planning of farm and rural buildings. The best of architects are usually failures in planning a barn, or any other farm buildings. We need men to study farm buildings, and how to plan and construct them so that the farmer may know how to get the most for his money, no matter whether he has $25 or $5,000 to spend. We want farm architects that can plan according to the money allotted and not make the cost 30 per cent to 100 per cent more than was anticipated or desired.

In addition to the regular mechanical courses, there is a place for a course in pure farm mechanics as applied to all phases of farm operations and the handling of farm machinery.

In connection with such a course it would be well to have a place for a permanent exhibit of farm machinery which would serve for instructional and demonstrative purposes for students and for farmers at any time they should desire to visit the institution. Farmers could then study the points of merit in various makes of machines under the guidance of a disinterested instructor and expert. Such a department and exhibit would give opportunity for devising and testing machinery for different purposes and determining the relative draft and strength of a machine and its parts.

DEMONSTRATION WORK

Demonstration work can be made a very effective force for good in agricultural education. The results of many investigations must be presented in this form before many farmers will fully appreciate and adopt the results.

Demonstration work can be of two general characters, viz: One which will really be an extension work of the Experiment Station, and allow them to present the results of investigations by object lessons both at the Station and in different parts of the state. This class of demonstration is generally limited to a single operation at a time. A second class of demonstration work that could be made equally valuable for College and Station purposes would be to have demonstration farms in close proximity to the institution that could be operated on a definite plan which would be sanctioned by the results of investigations. These farms would have detailed records of all their operations which would be an open book for students and farmers who desired to study them. These farms would also serve as places where a limited number of students who so desire could "learn to do by doing." Such farms when equipped should be made more than self-sustaining. To illustrate, it would be feasible to plan a combined fruit and poultry farm which would be a college laboratory in these departments, a farm where the most approved methods could be followed, and also serve as a model or demonstration as to what a man might do with such a combination. There are several types of dairy farms, market garden farms, hog farms and sheep farms which might be planned for this kind of demonstration work.

If such a plan would seem feasible and desirable, it would be necessary to acquire land which would be adapted to the several types of demonstration farms, as the work already in hand is using all of the present farm and if much extension of the investigations is made more land will also be needed for these.

In addition to the classes of demonstration already suggested, every agricultural high school in the state should be provided with demonstration plots and fields, and the county poor-house farms should be used for demonstration purposes.

EXTENSION WORK

All kinds of extension work should be pushed so as to get farmers acquainted with the best methods. Results may be ever so valuable, but they will yield no profit if the farmers do not know of them or put them in practice.

The plan of conducting station extension work by having well-versed agricultural agents make a farm-to-farm visit should be given a trial in at least one district, if not one county, in the state. Such an agent, if he had a full appreciation of his job, would make practically every farmer he visited a friend of this institution, and awaken in him a new pride and interest in his work which would soon result in better agriculture and do much towards raising average yields.

CEREAL AND FORAGE CROP INVESTIGATIONS

The following is an outline of the experiments now in progress in this department and those to be started this season. The work in the main is the same as has been carried on the last two years. Some will be broadened out more while some, like the breeding of alfalfa and clover, will be reduced greatly. Alfalfa extension will be carried on as much as time will permit; this will be in coöperation with the U. S. Dept. of Agriculture. After the results of this season it is proposed to get all data on alfalfa ready for publication.

In addition to the coöperative testing of varieties of corn conducted last season seven more tests have been added: One at Adamstown, one at Frederick, one at Middletown, one at Westminster and three in Garrett County. In each test there are eight or more varieties. It is planned to start breeding tests sometime in the future (next year if possible) at Frederick, Westminster and in the Middletown valley. The main object of this is to develop improved strains and to interest farmers in these sections in growing pure seed. It is unfortunately true that at present it is impossible to get a sufficient quantity of seed of the two best varieties of Maryland white corn. Next year the station will probably have considerable seed corn of two or three varieties for sale, but the more satisfactory way will be to get farmers interested in the seed business and let it be the business of the station to keep pure and develop improved strains of seed. This ought to be true also of many of the other principal farm crops.

The three variety tests started in Garrett County are located near Oakland and at Accident. Eight or ten varieties collected from different sections of the United States which would seem to be suited for that section are being tested together with local types to determine which variety or varieties are best adapted to the high altitudes and shorter season of the western counties. Those which prove best will be used as a basis for further improvement by breeding and selection.

At present there are a great many notes on experiments in this department taken the past two seasons which have not been worked up. It is planned to get these worked up as soon as possible and prepare the results of all experiments which have progressed far enough or have been completed for publication.

The new investigations are the sweet corn breeding work turned over from the chemical department. This fall, experiments are to be started to determine the cause of alfalfa fields dying out suddenly and to determine if hairy vetch seed can be grown profitably. There are many more new lines that ought to be taken up, but with the present facilities the additional new work planned is about all that can be taken up and carried through properly this season.

Other lines of work which ought to be started this season are investigations of buckwheat and of oats in the western part of the state. Probably the best way to start these investigations is to first conduct a variety test of each crop. There are now at least four or five varieties of buckwheat grown, but no one seems to be able to state definitely why a particular variety is preferred, or under what conditions each is best suited or if all are equally well suited under all conditions. The same is true of oats. After the variety test or in connection with it, other investigations can be taken up. Such as the selection of pure and better strains, cultural and harvesting methods, etc.

The question of what crops to grow and how to handle them to the best advantage when used for green manuring to bring up the fertility of poor land is asked by hundreds of farmers. This is one of the most important problems to work out. But this problem should not be undertaken until the proper facilities and enough funds are available to carry the investigations through for a number of years. The nature of the problem is such that little valuable data can be secured unless the investigations are thorough, complete, and extend over a period of four or five years.

AN OUTLINE OF THE INVESTIGATIONS CONDUCTED BY THE DEPARTMENT OF AGRONOMY

The work now conducted in this department is a continuation of that outlined in the Twenty-first Annual Report, together with new lines of investigation.

The following is an outline of the old work now in progress and the new lines of investigation taken up this season:

CORN

1st. Breeding of Leaming and Munnikhuysen corn.

2d. Testing of the degree of inbreeding or close breeding, which may be safely practiced.

3d. Testing Leaming seed from different sources.

4th. Variety tests at the Experiment Station, including 2 varieties.

5th. Coöperative variety tests with 12 farmers in different parts of the state.

6th. Rate of planting test, with 3 varieties.

SMALL GRAINS

1st. Wheat: (*a*) Breeding plots of Currell and Fultz. (*b*) 101 variety and selection plots.

2d. Fall Oats: 13 variety plots.

3d. Barley: 8 variety plots.

4th. Spelt: 6 variety plots.

5th. Emmer: (*a*) 2 variety plots. (*b*) 6 rate of seeding plots.

ALFALFA

1. Breeding for seed producing strains.
2. Testing seed from different sources.
3. Fertilizer tests.
4. Cutting experiments.
5. Date of seeding experiments.

CLOVERS—RED, MAMMOTH, ALSIKE AND WHITE

1. Breeding.
2. Tests of seed from different sources.

COW PEAS

1. Breeding plots of three varieties.
2. A variety test.
3. A study of the methods of harvesting and threshing cow-pea seed.
4. A test of corn when grown with and without cow peas.

NEW WORK

Breeding two varieties of sweet corn, Country Gentleman and Stowell's Evergreen:

1. For a higher percentage of sugar.
2. For a higher yield.
3. For uniform white color of cob and silk.
4. A study of the relation of physical character and sugar content.

Experiments to determine the cause of alfalfa fields dying out suddenly.

An experiment to determine if Hairy Vetch seed can be grown profitably.

BOTANICAL INVESTIGATIONS

The following investigations were pursued by the Botanical and Pathological department the past year:

1. Tests of the effect of various lime and sulfur sprays upon various crops, especially peach and plum; the valu of the same as fungicides and different methods of preparing the same.

2. Tests of iron sulphate and other chemicals as sprays for weed killing. The results give much promise in the use of iron sulphate, at least as a winter or early spring spray for chickweeds, etc., in grain, alfalfa, strawberries, etc., and probably for other purposes.

3. Investigations on the effect of various substances applied to plants internally. This was chiefly carried out by Mr. Barrows last summer and a considerable amount of data collected especially upon introducing substances through cut end of branches or roots, and upon the effect of salts upon plantains and other weeds.

4. A classification of the large collection of Maryland grasses made by the late Mr. Novik last summer has been begun.

5. Records are being made of all the information which can be obtained from various sources as o cause, prevalence, amount of injury and effective treatment of all economic plant diseases found in Maryland. In the "Report on Plant Pathology" for State Horticultural Society will be found the results of the work for 1908. This year (1909)

notes have been collected upon the occurrence of a great many diseases, chiefly in greenhouses, which have not been previously noted. These notes are being made with the idea of sometime issuing a bulletin on greenhouse diseases as a companion to Bulletin 119 on "Greenhouse Insects," but to make such work complete much study of the physiological diseases such as those occurring this winter on our greenhouse roses would have to be made.

CHEMICAL INVESTIGATIONS

In the chemical department the time of Dr. Fetzer has been entirely devoted to the dairy investigations as outlined below. Mr. Broughton has taken care of the routine chemical work or analyzing miscellaneous samples and has devoted as much time as possible to studies on the chemical and physical properties of unproductive soils, and upon the rate of diffusion of different forms of lime in different types of soils.

DAIRY CHEMISTRY

The work which occupied the time of the chemical department has been mostly with problems relating to the sanitary production of milk. It was in a great measure a continuation of the work originally begun two years ago and which consisted of pathological and physiological studies of milk and milk secretion.

In addition to the above there has been begun a microscopical and cell histological study of Colostrum. The question of the microscopy of the colostrum constituents is one which is quite unsettled, and in order to get at a good and sound solution of the leucocyte problem we must at least have a sound understanding of the colostral elements. It, therefore, seems important that this study be continued at such a time when it will not interfere with other work.

Other work which has been done and finished is "The effect of lime water on the digestibility of milk." This is being prepared for publication.

Some work has also been done with milks with a view of determining the possible cause of the improper emulsification or homogenization of milk during the course of preparing the so-called "clarified milk." So far this question appears to be one of a purely physical nature and which can be amply shown experimentally by passing an oily substance plus water through a filter paper—the oil, however, being previously incorporated with a calcium phosphate salt.

It is proposed for the coming year to continue the milk analyses in connection with the leucocyte work and to make only such determinations of substances as have been found to vary under the different conditions.

In this study the veterinary department will examine all samples of milk microscopically and the nature and amount of the cellular elements contained therein ascertained simultaneously with the chemical analysis.

DAIRY INVESTIGATIONS

The dairy department of this station has during the fiscal year completed and compiled results for publication of three lines of investigations as follows:

1. The Manufacture of Sweet Cream Butter.
2. Butter Making in Maryland.
3. Methods of Whipping Cream.

Investigations are now being conducted to ascertain the sources of contamination of milk as it is produced at the dairy barn; effect of velocity and direction of wind blowing from some sources of contamination, and effect of humidity of atmosphere on such contamination.

ENTOMOLOGICAL INVESTIGATIONS

The importance of a knowledge of insects is being recognized more and more by the general farmers and horticulturists of this state as of great benefit and in many cases as absolutely necessary to successfully produce certain farm crops. Indeed the health of the home and community, it has recently been learned, is dependent upon a proper understanding of the habits and control of many household pests. The field for investigation and study of these little creatures is ever increasing.

While the work of this department since its inception has been largely associated with the horticultural interests of the state, chiefly on account of the legislative act creating it, yet the work should not be restricted but the equipment and funds should be sufficient to look after insect troubles with all crops.

During the past year an outbreak of the Angoumois grain moth in Maryland caused damage to wheat in two counties, amounting to approximately twenty-five to thirty thousand dollars. This and what may be called the wholesale importation of nests of the notorious brown tail moth may be considered the most notable entomological features of the past year. It is indeed fortunate that the state was in position to act immediately in the protection of her agricultural and horticultural interests by the inspection of all imported nursery stock to prevent as far as is possible the escape of this the most destructive and otherwise noxious insect pest that this country has ever experienced.

A summary of the investigational work in progress is as follows:

TEST OF SPRAY MIXTURES

The necessity of annually treating fruit trees for the control of the San José scale results in a continued interest among fruit growers as to the effectiveness of the new washes that are constantly being put on the market. While the home-made lime-sulfur solution is generally accepted as being the most satisfactory solution to employ, the difficulty attending its preparation and application is reason for the demand for a solution which may be more easily handled and applied and at the same time be equally as effective and not injurious to the tree. In order to be able to intelligently answer the inquiries as to the usefulness of the many new patent washes that are being put on the market, it seems necessary to continue the actual testing of these solutions on a practical basis. The past spring two orchards have been selected in which to conduct these tests, namely, one at Boonsboro and one at Chestertown. Twenty-one solutions were applied in like manner and at about the same time in these orchards. In all 1700 trees have been treated with these different solutions.

CODLING MOTH

For the past three years experiments have been conducted with a view of determining the actual benefit that will be derived from treating apple trees for this pest. A study of the life history of this insect for Maryland has also been conducted along with the investigation. This past season the work has been enlarged and eleven different orchards are being employed for the work. In some of these the spraying has been done simply with a view of showing the neighborhood the possibilities derived from the treatment. As far as possible the orchards have been selected on the poor-house farms in the state. Only seven counties have accepted the proposition; namely, Wicomico, Worcester, Kent, Washington, Frederick, and Allegany. In the other counties there were no orchards on the poor-house farms or the commissioners were not sufficiently interested to coöperate.

WOOLLY APHIS AND GREEN APHIS

The work in the control of the woolly aphis has been continued. Two acres of ground have been selected in each of the two largest nurseries in the state and the seedlings put out have been treated with various strengths of tobacco dust. Likewise experiments will be conducted against the green aphis which is such a common pest throughout the state attacking various fruit trees. Experiments with tobacco decoctions and kerosene emulsions are being conducted with a view of seeking the best remedy for these plant lice.

ASPARAGUS BEETLES

The experiments inaugurated last year against the asparagus beetles will be continued this year. These tests have been conducted in co-operation with the Bureau of Entomology, U. S. Dept. of Agriculture, Washington D. C. Eight different treatments of spray solutions were employed with a view of seeing which would be most satisfactory.

FLEA BEETLES

This common pest of truck crops continues to serve as a very troublesome factor to many of these crops which are grown on such a large scale in this state; namely, tomatoes, melons, etc. Seventeen different tests for the control of these were made last season upon cucumbers and melons on the Station farm. The abnormal season caused the results to be inconclusive. It is therefore expected to duplicate these tests this coming summer.

PLUM CURCULIO

Experiments conducted for the past three years employing different spray solutions for the control of the pest will be continued this year, although it is possible that the killing of the fruit by frost will cause inconclusive results as has resulted in previous year's work. Last year excellent results were secured from spraying for the pest but the work was not considered to be sufficiently extensive to justify publication of results. This year the tests have been extended to include the treatment of summer apples, inasmuch as serious injury is occasioned each year to this fruit, in various parts of the state, by the curculio. It is therefore an annual pest to plums, peaches and apples, and it is hoped that the results from these tests in the near future will be conclusive.

PEACH-TREE BORER

This likewise is an experiment that has been conducted for the past two or three years on a rather limited scale. The subject is deserving of an extended investigation looking toward a more practical means of control than worming. Twenty different materials and solutions have been used upon the trees with a view of seeking some one which would be effective in preventing the adult moths of the insect depositing their eggs upon the trunks of the trees. As yet negative results have been secured.

DIPPING OF FRUIT TREES

While it was thought that the results of dipping experiments conducted by the department the past four years were sufficiently conclusive to publish in Bulletin No. 131 showing principally the inadvisability of such treatment, yet the varying results secured justify a further investigation of the treatment before it is either condemned or recommended for general use. It is therefore hoped to continue tests of dipping fruit trees in various solutions under different conditions this coming year.

HONEY BEES

Through the coöperation of the Bureau of Entomology. U. S. Dept. of Agriculture, an investigation of the bee-keeping industry of the State has been inaugurated during the past year. This investigation has taken the form of first learning the status of the bee-keeping interests in the state with a view of aiding bee keepers by givng them such information as will promote bee keeping. It is found that the dreaded diseases, American foul brood and European foul brood, exist in apiaries in different parts of the state. If some attention is not given to the control of these diseases the industry will be wiped out. There are now about 18 states in the Union which have laws governing the inspection of apiaries for these diseases, and it is hoped that means can be provided whereby assistance can be given the bee keepers of Maryland with a view of exterminating the diseases or reducing their occurrence as much as is possible. I am pleased to report that through the efforts of this department a State Bee Keepers' Association has been formed which has for its aim the promotion of the industry in the state.

HYMENOPTEROUS PARASITES

The following brief statement by Mr. A. B. Gahan who is working exclusively under the funds of the Adams act, will give the status of his work during the past year and plans for the future.

The investigation of hymenopterous parasites has proceeded along the following lines:

1. Rearing, collecting and mounting of parasites from as many different sources as possible.
2. Identification and classification of species collected as well as those already in the collection.
3. Description of new species.
4. Securing of notes on the habits and life histories of the different species new and old wherever possible.
5. Cataloguing of information obtained.
6. Incidental observations on life histories, habits, etc., of hosts and predaceous insects affecting same.

This work has entailed the collecting of rearing material, the mounting, preserving and examining of approximately 1500 specimens.

HORTICULTURAL INVESTIGATIONS

A few lines of work were completed and the results were published in Bulletins 132 and 133, the former on Irish potatoes and the latter on cabbage. The commercial fertilizer experiment on peaches with W. F. Allen at Salisbury was necssarily discontinued because the trees were taken out owing to the presence of San José scale, The truck crop experiment with Leo A. Cohill at Hancock could not be continued during 1909 owing to the increased amount of orchard spraying which required the time that was formerly given to this experiment.

A few varieties of English muskmelons were tested in the greenhouse during the winter.

The following lines of work are being carried on with fruits, nuts, vegetables and flowering plants.

Apples:

(1) Experiments with commercial fertilizers and cover crops in the orchards of:

(*a*) E. P. Cohill, Hancock.
(*b*) W. G. Dawson, Cambridge.
(*c*) J. S. Harris, Coleman.

(2) Breeding: Owing to very heavy freezing weather during April and earlier in the spring, most of the buds were killed on the varieties desired for breeding purposes and cross pollination was done on only 78 flower clusters.

The number of seeds secured in 1909 was 796, most of which have germinated.

(3) Cover crops in Experiment Station orchard.

(4) Spraying with different strengths of Bordeaux to find out with which strength the most fruit is held to the trees. The entomologist is using poisons in various strengths in connection with this work.

PEACHES

Variety testing orchards—100 varieties in each of two orchards.

(*a*) E. P. Cohill, Hancock.

(*b*) W. F. Allen, Salisbury.

PEARS

Breeding work. Pear blossoms were nearly as badly killed by freezing as were apple blossoms, so that only 145 blossom clusters were cross pollinated.

In 1908 the seeds obtained in pear breeding numbered 2112, of which 934 have germinated.

PAW-PAW

Several hundred seedlings from choice strains of fruit are being grown.

RASPBERRIES

Experiments in pruning and training and in distances apart of plants.

STRAWBERRIES

(1) Variety testing—about 150 varieties are in the testing beds.

(2) Mulching and spring cultivation tests.

(3) Improving varieties by seed selection.

(4) Testing preserving fluids to retain color and shape of berries.

PECANS

(1) Encouraging the planting of nut trees by the distribution of 1100 pecan trees of the best varieties over the entire state.

(2) Top and root pruning pecan trees at time of planting.

(3) Planting 90 pounds of pecan seed to obtain seedling stocks for grafting purposes.

PERSIAN WALNUTS

(1) Grafting and budding Persian walnuts on stocks of black walnut, Persian walnut and butternut. The grafts number 252, the buds 84.

(2) Growing Persian walnut seedlings of the best varieties.

ASPARAGUS

Commercial fertilizer tests.

CABBAGE

(1) Variety testing.

(2) Fertilizer tests with poultry manure supplemented with phosphoric acid and potash.

(3) Saving seed from disease-resistant and unfavorable weather-resistant strains.

(4) Excessive amounts of plant food on seed beds to determine effect on growth and maturity of plants.

(5) Fertilizers applied early in spring for comparison with fertilizers applied when plants are set in midsummer.

CELERY

Growing seed from Golden Self Blanching for testing with California grown seed of the same variety.

IRISH POTATOES

(1) Investigating the causes which affect yields.

(2) Growing seed in Garrett County, Maryland, for comparison with Maine grown seed.

(3) Keeping seed in cold storage for planting in June and July.

(4) Testing seedlings.

(5) Fertilizer tests with poultry manure supplemented with phosphoric acid and potash.

(6) Variety testing.

MUSKMELONS

Testing rust-proof Rocky Ford strains.

ONIONS

Fertilizer tests with poultry manure supplemented with phosphoric acid and potash.

SWEET POTATOES

Growing continuously on same soil.

TOMATOES

(1) Fertilizer tests with poultry manure supplemented with phosphoric acid and potash.
(2) Feeding with copper solutions to induce disease resistance.
(3) Variety testing.
(4) Variation effects of the use of excessive amounts of gypsum, lime, sulphur, iron filings, copper sulphate, phosphoric acid, soluble and insoluble, dried blood, muriate and sulphate of potash.

CARNATIONS

(1) Experiments with carnation cuttings in relation to vigor of plants.
(2) Improvement by selected seedlings resulting from self-pollination.
(3) Fertilizer experiments using cow manure without bedding, with litter bedding and with sawdust bedding.

GERANIUMS

(1) Variety tests for vigor, hardiness and disease resistance.
(2) Breeding to produce varieties adapted to Maryland conditions.
(3) Application of Mendal's law.
(4) Study of color relations.
(5) Hybridization.

ROSES

(1) Methods of ventilation as related to prevalence of mildew.
(2) Fertilizer experiments using cow manure without bedding, with litter bedding, and with sawdust bedding.

VIOLETS

Comparison of rich and poor soils and manures.

FERTILIZERS

(1) Effects of fertilizers on the structure of plants.
(2) Variation of plants by excess of plant food in various forms.

FERTILIZING AND PRUNING

To investigate the causes of the doubling of flowers and seed cells of the ovaries in various plants.

POULTRY INVESTIGATIONS

The work of the past year has been conducted according to the outline in the report for 1907–08, with the exception of Experiment No. 3 (the breeding of Barred Plymouth Rocks for egg production). This experiment was not fully planned at that time but has since been outlined and gotten under way. The experiments in progress at the present time are: Experiment No. 1, general test of poultry houses to ascertain if possible what type of house is best adapted to Maryland climate. Experiment No. 3, the breeding of Barred Plymouth Rocks for egg production. The work has been progressing very favorably, with the exception of some disease in the young stock during the summer of 1908 which was due to crowded conditions.

NEW WORK

During the year of 1907–08 a number of settings of eggs were sent to farmers in different parts of the state. The object in view was to introduce pure bred-stock, and to have the persons keep a careful record of the outgo and income, so as to give them an idea of the profit to be made from pure-bred poultry.

During the month of January the Poultryman spent several weeks visiting a large number of Maryland poultry farms. The object in view was to investigate the methods of those engaged in the industry, especially as to their commercial and practical value, so as to learn what factors contribute to success or failure. The trip was a success from every standpoint, and the data secured is now being prepared for publication.

During the spring a short series of lectures were delivered to the students of the Maryland Agricultural College and considerable interest was manifested on the part of the students.

IMPROVEMENTS FOR 1908-09

The brooder houses which were equipped with very small yards have been made more efficient by the addition of large commodious yards. A good substantial house has been erected for conducting Experiment No. 3, and has proven very satisfactory. A new gas machine and hot water heater have been installed in the basement of the main building, which have added greatly to the comfort and convenience of those carrying on the investigations.

The feed store room has been remodeled and a good cement floor and feed bins constructed.

The following donations were made to the poultry department the past year:

By the Boston Poultry and Dry Feed Hopper Co., Boston, Massachusetts:

12 large dry mash hoppers,
12 grit and shell hoppers,
12 chick hoppers,
1 large chick hopper.

By Cyphers Incubator Company, Buffalo, New York.

One 240, 1909 Model Incubator.
1 heating apparatus for old machine.

By Mandy Lee Incubator company.

1 Fireless Brooder.

By. F. W. Bird and Son, East Walpole, Mass.

Paroid and Red Rope roofing.

TOBACCO INVESTIGATIONS

The tobacco investigations are being pursued in coöperation with the U. S. Dept. of Agriculture. They are being conducted at Upper Marlboro in Prince George's County, at La Plata in Charles County, and at Chaney in Calvert County. The work in general can be divided into six classes:

1. Testing of varieties.
2. Improvement by selection and breeding.
3. Fertilizer tests.
4. Crop rotation with tobacco the money crop.
5. Crop rotation with potatoes the money crop.
6. Test of the residual effect of fertilizers applied for tobacco upon the other crops in the rotation.

One of these series of plots is located on the farm of Mr. F. Sasscer, located at the Upper Marlboro station of the Chesapeake Beach R. R. This one should run for at least 6 years. Another is located on the Fair Association property. The new work begun this year has been laid out on the following plan:

1st. Beginning this year and each year thereafter for five years there will be started a new series of 20th acre fertilizer plots with tobacco, one half of each plot being limed, and all the plots of each series carried one or more times through a five-year rotation system, to determine the residual effects of the fertilizers used on the tobacco and also to get data and to serve as demonstrations of the advantages from the systematic rotation of crops arranged so as to intersperse the humus-giving and soil-improving crops with the soil-depleting crops; to furnish food for live stock in large quantities; and to give sources of money return other than from tobacco. The rotation system proposed is as follows:

1st year, *tobacco,* seeded to wheat in fall.
2d year, *wheat* separately seeded to grass in August.
3d year, *grass* for hay.
4th year, *grass* for hay.
5th year, *corn* with crimson clover.

The rotation will then repeat, beginning again with tobacco on the 6th year. It will be nine years before the series of fertilizer plots last started will have been through the full rotation. The only series of tobacco fertilizer plots conducted this year will be that at the foot of the hill opposite the last year's Fair Ground plots. The land planned to come in this work in 1910 will be plowed and seeded this year in cowpeas and crimson clover.

2d. Beginning this year and each year thereafter for five years, there will be started a new series of 20th acre fertilizer plots with potatoes, of both early and late varieties, one-half of each plot being limed and all the plots of each series carried one or more times through a complete rotation system identical with that proposed above for tobacco. Owing to the late start, the experiments with early potatoes will be omitted in 1909. Beginning with 1910, the plan is to have the fertilizer experiments with potatoes so arranged as to try out each fertilizer mixture after peas and crimson clover and after a bare or weed fallow, in order to determine the effect of peas and clover on the yield of potatoes and their effect in modifying the fertilizer treatment to make it most profitable. For this purpose, every other plot in the series to be planted in 1910 will be seeded this year about July 1 to peas and crimson clover. This plan will be continued, possibly with slight modification, for each succeeding year's potato fertilizer experiments.

3d. Beginning this year and each year thereafter for five years, there will be started a new series of large size crop rotation demonstration plots 1½ acres each in size, using the best fertilizer as indicated by the smaller size fertilizer plots, and employing the very best methods of seeding, cultivation, handling, etc. These 1½ acre plots will be planted ½ acre in early potatoes, ½ acre in tobacco, and ½ acre in late potatoes, and each of these series of plots will be carried through a complete rotation similar to that mentioned above in connection with the tobacco and potato fertilizer plots. This is expected to give valuable data as to the profitableness of tobacco compared both with early and late potatoes, together with their comparative influence on the yield of succeeding crops and their effect in maintaining or building up the fertility of the soil.

The early potatoes will have to be omitted this year, but another standard late variety will be grown instead, which will give data as to their comparative value as yielders.

In connection with these ½-acre plots of potatoes valuable data for Southern Maryland conditions will be obtained as to the effectiveness of spraying for blight by spraying half of each plot and leaving the other half unsprayed.

The 1½-acre plot intended for potatoes and tobacco in 1910 will this year be planted in cowpeas and crimson clover.

4th. Variety tests of potatoes will be conducted each year on small plots, using for comparative purposes about 5 or 6 varieties each of early and late potatoes.

This plan by the 5th year will bring into use about 20 acres of land.

VETERINARY INVESTIGATIONS

During the year this department has been engaged principally in the study of the cow's udder.

Externally a comparison by shape, dimensions and general character has been made of all cows in our herd with reference to breeding, age, size and milk production. This comparison revealed the necessity for a more detailed and elaborate scheme for scoring than that provided in the score card for dairy animals. Such a scheme was worked out and used in scoring these udders.

The circulation of blood in the udder was studied, and here too it was found necessary to devise a suitable injecting apparatus. This was perfected in a series of trials with crude appliances, until an outfit of tanks and a pressure pump gave almost ideal results, and in addition to its use for this purpose, is applicable to all forms of vascular injection necessary for anatomical study.

The histology of the udder is deficient in regard to the distribution of lymphatics and the mode of nerve endings. This will require further work and will probably be taken up during the present year.

The test begun several years ago to determine the efficacy of Bovo-vaccine in the suppression of tuberculosis has proceeded far enough to warrant certain conclusions and these are based upon the same conditions as apply to the detection of tuberculosis with tuberculin; viz: In order to secure proper results it is imperative that the most careful and painstaking efforts to comply with the technique of the work be followed and when so carried out it would seem that:

1st. Bovo-vaccine greatly increases the resistance to tuberculosis for at least two years after vaccination is completed.

2d. Tuberculin is practically infallible in the detection of tuberculosis in cows.

3d. Bovo-vaccination and tuberculin injections are not operations of a character that they can be recommended for indiscriminate application by laymen or others not in a position to attend to the details of the work.

4th. That all work of this character and the sale of all such biological products should be under the supervision of proper State authorities.

Leucoencephalitis in horses has been observed in isolated cases but no further light has been thrown upon its cause, prevention or cure.

A compilation of the dairy herd records of our station has apparently shown an important relation between services and abortions, where contagious abortions exist, and if borne out by other records will establish a principle in treatment of this disease of the highest economic importance.

For the ensuing year two lines of work will be pursued, viz:

FAT CELLS

1. A study of the size and properties of fat cells as they exist in milk of the different breeds.
2. The relation of size of fat cells to fat content.
3. The character of the emulson and relation to size of fat cells.
4. The resistance which fat cells have for coalescence.

INFLAMMATION

The determination of the relation of bacteria, leucocytes and chemical changes in milk as affected by inflammation.

The equipment for milk studies needs to be enlarged by the purchase of a laboratory separator, Babcock tester, additional reagents and supplies, and a laboratory microtome.

PUBLICATIONS

The following is a list of the publications issued during the past year:

Bulletin			Pages
129	Silos and Silage in Maryland; by	Howard L. Crisp H. J. Patterson	1–78
130	Nurseries and Nursery Inspection	T. B. Symons J. B. S. Norton C. P. Close	79–128
131	Treatment for San José Scale; T. B. Symons		129–149
132	Irish Potato Investigations	C. P. Close T. H. White	150–174
133	Cabbage Experiments and Culture by C. P. Close		175–200
134	Flies, Mosquitoes and Brown Tail Moth; T. B. Symons		201–224
135	Butter Making in Maryland; C. W. Melick		225–284
136	Whipped Cream, by C. W. Melick		285–300

FINANCIAL STATEMENT

The following reports of the treasurer show the revenue of the station and the way it was expended the past year:

HATCH FUND

Maryland Agricultural Experiment Station, in account with the United States Appropriation.

Dr.

1909	
To receipts from the Treasurer of the United States as per appropriations for the fiscal year ended June 30, 1909, as per Act of Congress, March 2, 1887	$15,000.00

Cr.

Salaries	$10,831.63
Labor	2,377.56
Publications	188.66
Postage and stationery	150.60
Freight and express	198.99
Heat, light, water and power	297.84
Chemical supplies	15.65
Seeds, plants and sundry supplies	320.42
Library	195.25
Tools, implements and machinery	149.23
Furniture and fixtures	97.00
Live stock	90.51
Buildings and repairs	76.56
Contingent expenses	10.00
Total	$15,000.00

The above is a true copy of the books of this office.

Frank R. Kent,
Treasurer Maryland Agr. Exp. Station.

ADAMS FUND

Maryland Agricultural Experiment Station, in account with the United States Appropriation.

DR.

1909		
June 30	To receipts from the Treasurer of the United States, as per appropriation for the fiscal year ended June 30, 1908, as per Act of Congress, March 16, 1906	$11,000.00

CR.

1909.		
June 30,	By salaries	$7,686.99
	Labor	252.00
	Postage and stationery	42.12
	Heat, light and water	207.12
	Chemical supplies	325.53
	Seeds, plants and sundry supplies	184.61
	Fertilizers	8.00
	Feeding stuffs	651.05
	Library	299.74
	Tools, implements and machinery	200.83
	Scientific apparatus	551.92
	Furniture and fixtures	112.53
	Live stock	329.75
	Travelling expenses	33.63
	Buildings and repairs	114.18
		$11,000.00

The above is a true copy from the books of this office.

FRANK R. KENT,
Treasurer, Maryland Agr. Exp. Station.

STATE FUND

Maryland Agricultural Experiment Station, in account with the State of Maryland Appropriation:

DR.

1908		
July 1,	To cash balance	$427.72
	From State	7,500.00
	Interest	7.38
		$7,935.17

CR.

1909		
June 30,	By repairs	$991.98
	Publications	1,297.86
	Exhibits	66.12
	Freight and express	470.12
	Feeding experiment	693.61
	Tobacco experiment	691.52
	Poultry experiment	716.91
	Insurance	233.25
	Labor	947.91
	Seeds, plants and sundries	160.15
	Tools, implements, machinery	62.03
	Chemical supplies	4.10
	Travel	278.21
	Salaries	771.31
	Postage and stationery	63.70
	Irrigation and drainage	443.42
	Furniture and fixtures	38.35
	Balance	22.46
		$7,935.17

The above is a true copy from the books of this office.

FRANK R. KENT,
Treasurer Maryland Agr. Exp. Station.

HORTICULTURAL FUND

The Maryland Agricultural Experiment Station, in account with the State of Maryland Appropriation for Horticultural Investigation.

Dr.

1908		
July 1,	To cash balance	$2,954.39
	Interest	6.68
		$2,961.07

Cr.

Salaries	$490.00
Seeds, plants and sundry supplies	1,226.64
Travel	163.96
Library	74.06
Labor	136.88
Fertilizer	125.36
Postage and stationery	133.38
Tools, implements and machinery	131.49
Heat, light and water	38.50
Publications	196.86
Freight and express	235.65
Balance	8.29
	$2,961.07

The above is a true copy from the books of this office.

FRANK R. KENT,
Treasurer, Maryland Agr. Exp. Station.

STATION FARM FUND

Maryland Agricultural Experiment Station, in account with the Station Farm.

1908 Dr.

July, To balance	$11.39
Sale of stock and produce	4,725.86
Interest	8.61
	$4,745.86

Cr.

Live stock	$840.00
Fertilizer	459.94
Feed stuffs	651.55
Travel	300.00
Freight and express	335.66
Trustees' expenses	385.00
Seeds, plants and sundry supplies	139.10
Labor	1,577.39
Balance	57.22
	$4,745.86

The above is a true copy from the books of this office.

Frank R. Kent,
Treasurer, Maryland Agr. Exp. Station.

THE MARYLAND

Agricultural Experiment Station

BULLETIN No. 129 JULY, 1908

SILOS AND SILAGE IN MARYLAND

The Construction of Silos and the Making and Feeding of Silage

BY HOWARD L. CRISP AND H. J. PATTERSON

INTRODUCTION.

While silos and silage have been in use in Maryland for more than 30 years yet there are many questions that arise in the minds of those who are about to adopt this method of preserving and using feed that require more detailed information than is available to most Maryland farmers. The matter in this bulletin has been compiled with an idea of collecting some detailed information from the users of silos and silage in Maryland and putting the results of the experience of these practical farmers within the reach of their brothers and thus encourage if possible the more general use of silage. The use of silage has increased greatly in Maryland during the last few years, but there are thousands of farmers who are feeding dairy and fattening cattle who could profitably adopt the silo.

The matter with reference to the construction of silos, the sketches, photographs, estimates of materials, etc., were made by Mr. Howard L. Crisp, assistant in the Mechanical Engineering Department of the Maryland Agricultural College. The matter giving information as to making and feeding silage, and the preparation of all the material for publication has been done by H. J. Patterson.

DEFINITIONS.

As there is still much confusion in the terms used by speakers and writers in connection with this subject it may not be out of place to give here the more generally accepted and modern meanings of the terms used. The word *Silo* signifies any air-tight structure used for the preservation of forage in a succulent condition. The feed taken out of the silo is *Silage* (formerly and originally called *ensilage*). The process of putting feed into the silo is frequently designated by the words, *to silo*, *ensilaged* and *ensiloing;* but more generally spoken of as *making or cutting silage.* The farmer who makes and uses silage is sometimes called a *siloist.* The particular kind of silage is designated by prefixing the name of the crop used for making it, as Corn silage, Clover silage, Cowpea silage, etc.

HISTORY.

The history of silage dates back to antiquity; but it was not until 1875 that it attracted much attention or that it can be said to have been introduced into modern agriculture. In 1875 Auguste Goffart, of France, announced the results of his experiments, which had covered several years, with preserving green forage; and for the successful outcome of which he was awarded by his government (in the same year) the Cross of the Legion of Honor.

The first silage made in America was prepared by Francis Morris, of Ellicott City, Maryland, in 1876, by putting whole corn in a trench or pit dug in the ground and covered with earth. He reported that he found it fairly well preserved and that stock ate it well. The first silo was built by Dr. J. M. Bailey, of Boston, Massachusetts, the successful opening of which was reported in "The Country Gentleman" in December, 1879. This report, together with Dr. Bailey's "Book of Ensilage" published in 1880, brought the subject of silos and silage prominently before the farmers of the United States and resulted in many adopting this method of preserving feed and becoming enthusiastic advocates of the practice. From this beginning the use of the silo has spread rapidly until today there are few dairy sections where silos are not common and in general use.

ADVANTAGES OF SILOS AND SILAGE.

The advantages which are obtained through the use of a silo for preserving coarse fodders for the feeding of farm animals may not be the same for each individual case; but the points enumerated herewith will probably hold in the majority of instances and cover average conditions.

1. The product of an acre of land can be stored in less space by making it into silage than by curing in any other way. Hay placed in

the mow will take up about three times the space and corn fodder about five times the space as the same quantity of food materials placed in the silo.

2. An acre of corn can be placed in the silo at less cost than the same quantity can be put up as cured fodder. The usual method of cutting and shocking the crop, then husking, cribbing, shelling, grinding the grain, storing and shredding the fodder and then putting them together again is expensive and would seem to require much labor that might be obviated if the whole crop was secured at one time as is done in putting it in the silo. The storage of the corn crop in the silo makes it possible to clear the ground completely and earlier, and thus facilitates the preparation of the land for seeding grass and fall grains.

3. The use of a silo makes it possible to use smaller buildings thus reducing, the cost of plant, the interest on investment, the cost of repairs and insurance and the risk from fire.

4. The use of the silo makes it possible to preserve roughage so as to entail a minimum of loss of food and feeding value. Tests have shown that the loss through the breaking off of leaves and tender parts and through the fermentation changes in curing fodder in ordinary farm practice amounts to 10 to 25 per cent, while the loss in the crop if put into a silo is only about 10 per cent and by following the practice of many dairymen of beginning to feed from the silo as soon as it has been filled the loss can be reduced to a minimum and should not be over 5 per cent.

5. Crops can be secured in the silo during weather that could not be availed of to make hay or cure fodder.

6. More cattle can be kept on a given area of land when silage is fed than when the roughage is cured for hay or fodder, or when the land is used for pasture purposes.

7. Crops unfit for making hay will often make a nutritious, palatable silage and thus enable the farmer to carry his stock during times when hay crops are a failure.

8. The use of silage enables the feeding of a succulent and uniform food the entire year. Silage is beneficial to digestion and general health of animals. It is a mild laxative and keeps the digestive system about in the same condition as when animals are on pasture or being fed with green fodders. The feeding of silage previous to turning animals out to pasture is beneficial and prevents the loss in weight which frequently occurs.

9. Silage is valuable for supplementing the pastures at such times

as they are short and thus preventing animals from losing flesh or falling off in their flow of milk.

10. The use of silage enables animals to be fed more economically than by the use of dry roughage and usually yields a better quality and greater quantity of product. This is true both in the production of meat and milk.

GENERAL OBSERVATIONS AND SUGGESTIONS ON SILO CONSTRUCTION.

Before giving details as to the construction of particular silos it may be well to give a few of the fundamental principles which have been determined, so as to enable a person constructing a silo to include the essential features and avoid serious mistakes, no matter what type may be built.

It is highly important to build a thoroughly good silo. That is a silo that will keep the silage in good condition and reduce the loss of feed to a minimum. Each ton of silage which spoils represents the interest on about twenty dollars, consequently it requires but little calculation to determine that it will pay to spend enough to make a silo that will keep the silage. In constructing a one-hundred-ton silo do not build a cheap and imperfect structure, but spend $100.00 to $150.00 more and construct a silo that will keep the silage, rather than one that will allow 10 to 20 tons of silage to spoil each year.

The following points should be observed as closely as possible:

1. Make the bottom and sides of the silo air tight. Much silage spoils because of air getting in at the bottom or at the sides or around the doors. The silo should be either tight all the time or in such a condition that the damp silage will cause it to swell tight in a few hours after filling.

2. The silo must be relatively deep. Depth is essential in order that the siloed fodder will pack well and develop considerable pressure and thus exclude the air as completely as possible. A silo should be two to three times as deep as the diameter.

3. The silo should have smooth perpendicular walls so as to facilitate the packing and even settling of the siloed fodder.

4. Have as few corners as possible so as to facilitate thorough packing. Corners are difficult to pack and are generally the place where most loss occurs.

5. The floor should be firm, smooth, air tight and rat proof, and give good drainage. They may be made of stiff clay or concrete.

6. The foundation should be substantial, strong, and extend below frost line, and when a wood superstructure is used the foundation should be at least 18 to 24 inches above the surface of ground so as to keep dampness and decay from the ends of the boards or sills. The sills, or with stave silos, the ends of the staves should be treated with some preservative and bedded in tar and cement so as to exclude the air. The foundation of a silo should be even more carefully constructed than that of a house.

7. A roof is not absolutely essential on a silo but, all things considered, will generally be found desirable. There should be some ventilation provided in the roof so as to allow the escape of dampness and gases which develop in the fermentation of the silage.

8. There are a great many styles of doors all of which may possess some special advantage over others. Most persons favor some kind of a continuous door from top to bottom rather than the style with doors at intervals. In all cases the door should be made so as to be tight and not admit air. This is a weak point with many silos and much silage spoils on account of leaks around the door.

THE CAPACITY OF THE SILO.

The size of the silo to be built should be determined by the amount of stock to be fed and the length of the silage feeding season. In most parts of Maryland it will usually be found desirable to have silage available from six to seven months, and in sections where summer pastures are limited or subject to being cut short by dry weather it is well to provide for supplementing the pasture, particularly up to the middle of July or the period when soiling crops can be depended upon.

Silage is usually fed to cows and steers at the rate of 30 to 40 pounds per day. This would mean that in 200 days a cow would require from 3 to 4 tons of silage. These figures give a safe basis for calculating the requirements of a herd.

The size of the silo should be such as to make it possible to feed daily from the whole surface of the silo to a depth of two inches; so as to prevent loss by undue exposure of the silage to the atmosphere and keep it in the best condition for feeding.

Silage weighs from 30 to 50 pounds per cubic foot. Good corn silage averages about 35 to 40 pounds. Clover and cowpeas silage weigh more than corn silage. One acre of corn should yield from 10 to 15 tons of silage and one acre of clover, vetch, cowpeas, rye, etc., should yield form 8 to 10 tons of silage.

APPROXIMATE CAPACITY OF CIRCULAR SILOS, IN TONS.

(Estimated on the basis of silage made from well matured corn.)

Height of Silo.	INSIDE DIAMETER OF SILO—FEET.						
	10′	12′	14′	15′	16′	18′	20′
feet.	*tons.*	*tons.*	*tons.*	*tons.*	*tons.*	*tons.*	*tons.*
20	26	38	51	59	67	85	105
21	28	40	55	63	72	91	112
22	30	43	59	67	77	97	120
23	32	46	62	72	82	103	128
24	34	49	66	76	87	110	135
25	36	52	70	81	90	116	143
26	38	55	74	85	97	123	152
27	40	58	78	90	103	130	160
28	42	61	83	95	108	137	169
29	45	64	88	100	114	144	178
30	47	68	93	105	119	151	187
31	49	70	96	110	125	158	195
32	51	73	101	115	131	166	205

In calculating the capacity of rectangular silos, forty pounds may be taken as the average weight of one cubic foot of corn silage. One ton of silage will accordingly take up 50 cubic feet; and 100 tons, 5000 cubic feet. If a rectangular one-hundred-ton silo is to be built it may be 12 x 14 feet and 30 feet high, or 12 x 12 x 35 feet, or 13 x 13 x 30 feet.

From the above figures a farmer may plan his silo and the area of silage crops to meet his requirements.

SILAGE CROPS.

The crops most available for making silage in Maryland are corn, sorghum, cowpeas, soja beans, winter vetch, clover, wheat, rye, oats and millets. These may be grown and used either separately or in various combinations.

All silage crops should be harvested when thev are fairly well matured. Corn is in the best condition for the silo when the kernels are nicely glazed or in about the same condition that it would be cut for saving the grain. Other forage crops should be cut for silage when in about the proper stage or best condition for making hay.

Corn from the ease with which it can be grown and converted into silage is entitled in most places to head the list of forage crops for this purpose. Corn is adapted to a wide range of soils and conditions and will usually produce more silage per acre than any crop that can be grown.

Corn will usually yield from 10 to 15 tons per acre, and larger amounts are frequently reported even up to 30 to 40 tons.

In selecting a variety of corn for silage always use one that will mature its grain as such strains will make the best of silage. Other things being equal, varieties that produce a large fodder will be found most desirable. The Cocky's Prolific and Hickory King types of corn are very good as they give a high yield and produce three or four small ears per stalk instead of one large ear and consequently they are easier on the cutting machinery.

Silage corn can be planted a little thicker than is ordinarily used in growing grain, but it should not be planted so thick as to prevent a good ear development. The thickness will depend upon the soil and the varieties used.

Corn and Cowpeas: This combination has proven very good at this Station and in many places where tried. The practice here is to plant the corn and the cowpeas at the same time using a planter with two hoppers for this purpose. The spouts from the hoppers are arranged so that the peas and corn are dropped in the same hill. The quantity of seed used can be regulated by the plates, but usually it is found best to have one plant of each at a place.

The variety of peas for this purpose will probably vary with location. The ones which have proven best from the results of experiments at this Station are the Wonderful, the Red Ripper and the Whip-poor-will cowpeas and the Virginia Cornfield bean. The variety of peas should be selected so that both corn and peas are in condition for putting into the silo at the same time. Many of the peas mature too early for satisfactory results.

The results at this Station have shown that the growing of corn and cowpeas in combination increases the yield of corn, that is, there was more corn on the plats that had peas than on those that had none. The average advantage has been in increasing the yield of silage about three tons per acre and in improving the quality 25%. The land was also left in better condition.

Sorghum is a fairly good crop for silage though usually not as easily grown as corn, except on very dry soils. The hard covering of the stalk makes it more or less unpalatable to stock. The saccharin varieties of sorghum make a more acid silage than corn. Cowpeas can be grown in combination with sorghum the same as corn. Sorghum and cowpeas grow satisfactorily when sown broadcast.

Cowpeas and soja beans both make good crops to grow for winter silage. They may be put into the silo by themselves or mixed with corn. They make a good quality of silage which cattle soon learn to like and do well on. Cowpea and soja bean silage does not become as acid as corn silage and they will weigh more per cubic foot. They yield from 6 to 10 tons of silage per acre.

For summer silage crimson clover, red clover, winter vetch, rye, wheat, and vetch and wheat, or vetch and winter oats, grown in combination are very satisfactory crops. They will yield from 6 to 12 tons of silage per acre.

METHODS OF HANDLING SILAGE CROPS.

The harvesting of corn and sorghum for the silo may be done by hand with the ordinary corn knife, but the corn harvester or binder will be found a valuable implement for this work. The corn binder not only facilitates the cutting of the crop in the field; but having the corn tied in bundles makes the loading of it on the wagon and feeding it into the fodder cutter much easier and quicker.

In harvesting the finer growing forage crops, the mower and rake will answer all purposes. Great care should be taken to avoid raking up stones and other foreign bodies which might injure the fodder cutter.

For hauling silage crops the use of wagons with low wheels have many advantages but when this kind of wagon is not available building up a platform on the regular wagons which will throw the load above the wheels and standards will be found to facilitate the unloading after the manner shown in fig. 1.

FILLING THE SILO.

For best results forage which is put into a silo should be cut fairly fine so that it will pack close and exclude the air as much as possible. This material can be conveyed into the silo by means of an elevator or conveyor. There are a few favored sections that can locate the silo so that it may be filled from the cutter by gravity. The silo may be filled with uncut forage, but this is not advisable if cutting machinery can be procured, as the silo will not hold as much and the material in its natural shape will not pack tight enough to keep as well as when cut. If the amount of silage to be put up will not warrant a farmer in owning a cutting outfit they can usually be hired in most neighborhoods upon about the same basis as a threshing machine.

The silo may be filled all at once or gradually from day to day as may suit the owner's convenience.

In slow filling the work should be done at least rapidly enough to prevent any mold from forming at the surface. In rapid filling a day or so must be allowed for settling and the silo filled up a second or third time so as to utilize all the space.

In all cases it is important to have the forage packed into the silo as tight as possible. Tramp it very thoroughly around the edges.

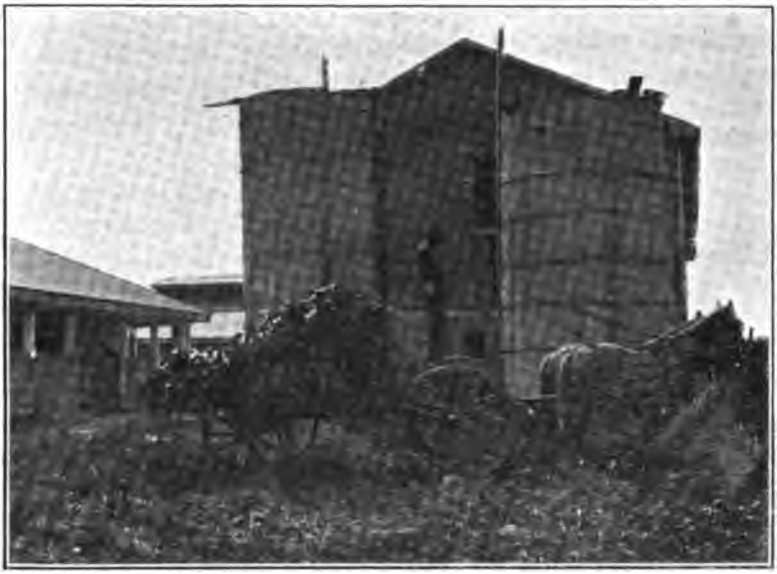


Fig. 1. Showing a method for unloading fodder at silage cutter. Note the double rope which is placed on the bottom of the wagon and passes over the top of the load which can be hooked into a chain fastened to a short post in the ground. The team moving on pulls the load off.

After the silo is full and nothing more is to be put in, wet the top at the rate of about one gallon per square foot and then tramp it down thoroughly. This causes a compact decomposed mass to form on the top which effectually excludes the air and reduces the amount of spoiled silage to a minimum.

A plan pursued by many farmers which works very well is to give a heavy sprinkling of oats, wheat or rye over the top of the silage before wetting. This grain sprouts and forms a very dense growth of roots with a thin layer of decomposed material which affords a good protective covering for the silage and allows very little to spoil.

The practice of many to keep silage from spoiling is to begin feeding it at once, using only a very thin layer each day or just enough to prevent its spoiling.

POISONOUS GAS IN THE SILO.

The top of the silo should be ventilated, and if there is much space between the top of the silage and the top of the silo, or between the bottom of the silo and the lower door, without ventilation, care should be taken in going into the silo as there may be enough carbon dioxide gas formed to cause suffocation. This can be tested by lowering a lantern to the bottom of the empty space. If the light continues to burn it will be safe to enter, if it goes out dangerous. If the silo should be found to contain an injurious amount of carbon dioxide it can be removed by agitating the air with a bundle of hay or the branch of a tree lowered into the silo with a rope.

FEEDING SILAGE.

When judiciously used silage can be fed with advantage to all classes of farm animals.

Silage should not be fed as an exclusive coarse feed, but always in connection with some dry roughage. The nearer the maturity the forage is cut for the silo, the more silage may safely be fed, but it is always well to avoid feeding it excessively.

The difference in the chemical composition and digestibility of the same forage green, dried, and in the form of silage, is very slight and the relative feeding value of the different forms is dependent chiefly upon their palatability and physical effect. Silage is usually more palatable to animals than dry feeds and it acts as a mild laxative and keeps the digestive system in better condition than is usual with most dry feeds. Silage, green soiling feeds, and pastures seem to keep the digestive system in about the same condition. Silage furnishes that succulency in a ration that seems necessary for stock to do their best work.

Some years ago the writer of this Bulletin conducted an extensive set of digestion experiments in comparing silage and corn fodder (4th Annual Report, 1891) in summing up the results of which the following statement was made:

We see there is but little difference between the digestibility of the silage and the fodder rations, the slight difference which occurs being in favor of the silage. But we must not overlook or forget the fact that this slight difference is in all probability due to the difference in methods of growing the fodder and not to any extent to be attributed to the ensiling. Corn stover (fodder) has been found to differ but slightly in digestibility from corn fodder or corn silage. The digestibility of the crude protein is very nearly the same in each, that of the silage being slightly the higher. The fat in the silage is also more digestible, but this may be due almost entirely to the amount of acid which the silage contains.

COMPOSITION OF SILAGE.

From the table given below it will be noted that most of the silages are relatively low in protein, and this is particularly true of the corn silages. In order to supplement this the farmer should aim to grow the protein feeds like clover, alfalfa, peas, and vetches, to as large an extent as practicable and thus be able to feed a balanced ration without purchasing the expensive by-product protein feeds. The composition of the silage will vary with the maturity of the forage crop used.

TABLE SHOWING THE COMPOSITION OF VARIOUS SILAGE CROPS.

In pounds per hundred (per cents).

	Water.	Ash.	Crude. Protein.	Crude Fiber.	Nitrogen Free Extract.	Fat.
Corn silage—mature corn	73.7	1.6	2.2	6.5	15.1	0.9
Corn silage—immature corn	79.1	1.4	1.7	6.0	11.0	0.8
Corn silage—ears removed	80.7	1.8	1.8	5.6	9.5	0.6
Clover silage	72.0	2.6	4.2	4.8	11.6	1.2
Soja bean silage	74.2	2.8	4.1	9.7	6.9	2.2
Cowpea vine silage	79.3	2.9	2.7	6.0	7.6	1.5
Canada pea vine silage	50.0	3.6	5.9	13.0	26.0	1.6
Corn cannery refuse—husks*	83.8	0.6	1.4	5.2	2.9	1.1
Corn cannery refuse—cobs*	74.1	0.5	1.5	7.9	14.3	1.7
Pea cannery refuse*	76.8	1.3	2.8	6.5	11.3	1.3
Sorghum silage	76.1	1.1	0.8	6.4	15.3	0.3
Corn-soja bean silage	76.0	2.4	2.5	7.2	11.1	6.8
Millet-soja bean silage	79.0	2.8	2.8	7.2	7.2	1.0
Cowpea-soja bean silage	69.8	4.3	3.8	9.5	11.1	1.3
Rye silage	80.8	1.6	2.4	5.8	9.2	0.3
Apple pomace silage	85.0	0.6	1.2	3.3	8.8	1.1
Brewers Grains silage	69.8	1.2	6.6	4.7	15.6	2.1

*=Analyses made at the Maryland Experiment Station from samples procured of B. F. Shriver & Bro., Union Mills, Carroll Co., Maryland.

SILAGE FOR COWS.

Silage is more used in rations for dairy cows than for any other class of animals. In fact it has been prominent in bringing about the present development of the dairy industry and enabling the maximum production at the minimum cost. Silage is well liked by cows and they thrive on it, make liberal yields and maintain good health. Since silage is relatively rich in carbohydrates and low in protein, clover hay, cowpea hay, and alfalfa hay are all good as a supplementary roughage. From thirty to fifty pounds is the usual daily allowance of silage for a cow.

SILAGE FOR STEERS.

The progressive feeder of beef cattle will find that silage is just as important in the economical production of flesh and fat as the dairyman does in the economical production of milk. Corn silage will furnish a cheap succulent winter feed for cattle that will keep the system cool and the appetite vigorous. The quality of silage fed beef is better than on dry roughage. In the early stages of feeding a 1000-pound steer can be fed 40 to 50 pounds of silage and then reduced to about one-half that amount when on a full grain ration and towards the end of the feeding period.

SILAGE FOR SHEEP.

Silage is looked upon with great favor among sheep men. Succulent food is imperative for successful sheep raising, and this is particularly true in raising fine early lambs. Silage on most farms will furnish this succulency cheaper than root crops. Silage is inclined to be fattening and should be fed in limited quantities to breeding ewes. Silage fed ewes give strong vigorous lambs and drop them without trouble. Ewes should be fed from 2 to 4 pounds of silage per day per head. Fattening sheep may be fed double these amounts.

SILAGE FOR HOGS.

Hogs do not like silage and they will not eat much of it so that it is of little economic importance in feeding them. This Station has fed corn and cowpea silage to hogs but it was eaten in such small quantities as to have practically no effect on the ration. Some few reports have been made through the agricultural press of great success in feeding clover silage to hogs, but tests at the Wisconsin Station have not been satisfactory.

SILAGE FOR HORSES AND MULES.

Silage is too bulky to be considered an ideal feed for horses or mules which are at work, though it has been fed in limited quantities in numerous cases with success. A little of it acts as a mild laxative and will keep the digestive system in good condition. Silage fed horses keep in good condition and look well. Silage should be fed to horses in small quantities at first. Some horses object to silage at first but usually they soon learn to like it. Brood-mares and idle horses may be fed larger quantities than work horses, but in neither case should the quantity be large or form the entire roughage portion of the ration but it should be supplemented with some hay or straw.

DESCRIPTION AND NOTES TAKEN ON MARYLAND SILOS.

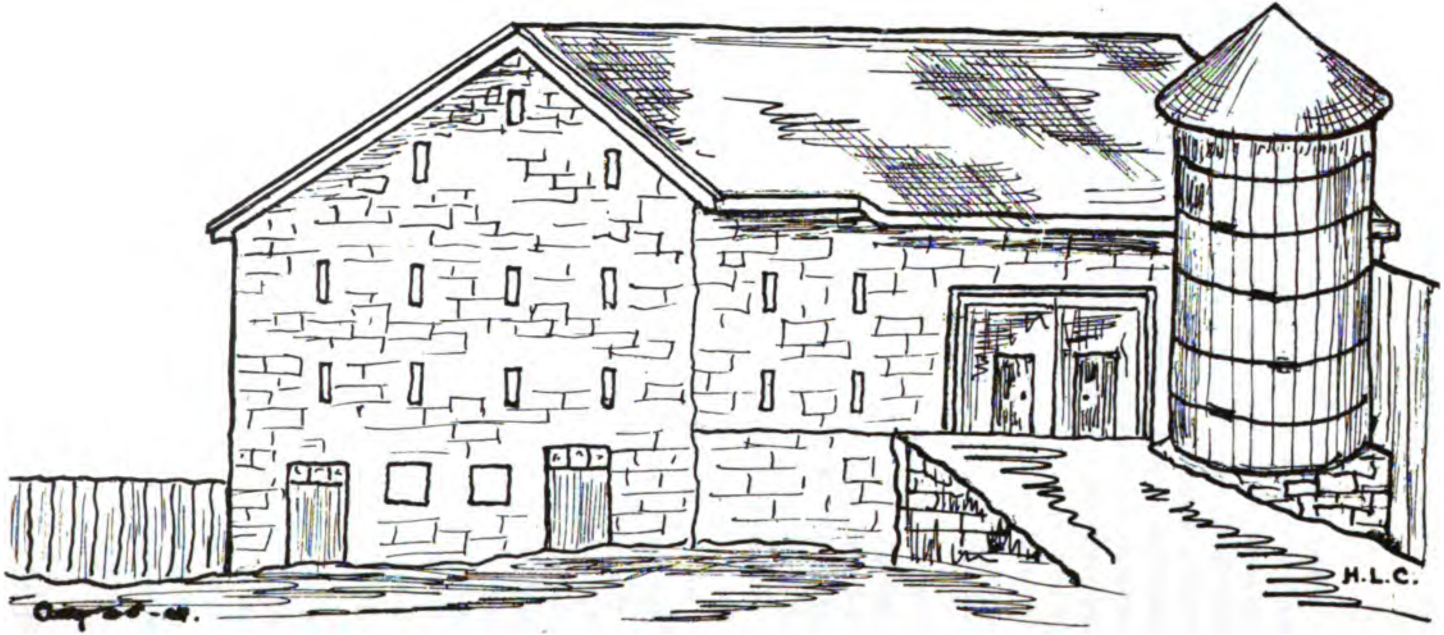
Mr. H. L. Crisp visited during the summer of 1907 about eighty farms in different parts of Maryland and took pictures, made sketches and collected a miscellaneous lot of data that may be helpful to those who contemplate the construction of a silo. This data has been compiled in the notes given on the following pages.

The notes are numbered in the order in which the farms were visited. The pictures, sketches cross-section, etc., are numbered to correspond to the respective note. In giving the dimension of silos the height is always given last. In round silos the first dimension given is the diameter. The capacity given is that claimed by the owner which does not always agree with the estimated amount given in the table on page 6. This discrepancy will account for the variation in yields frequently reported.

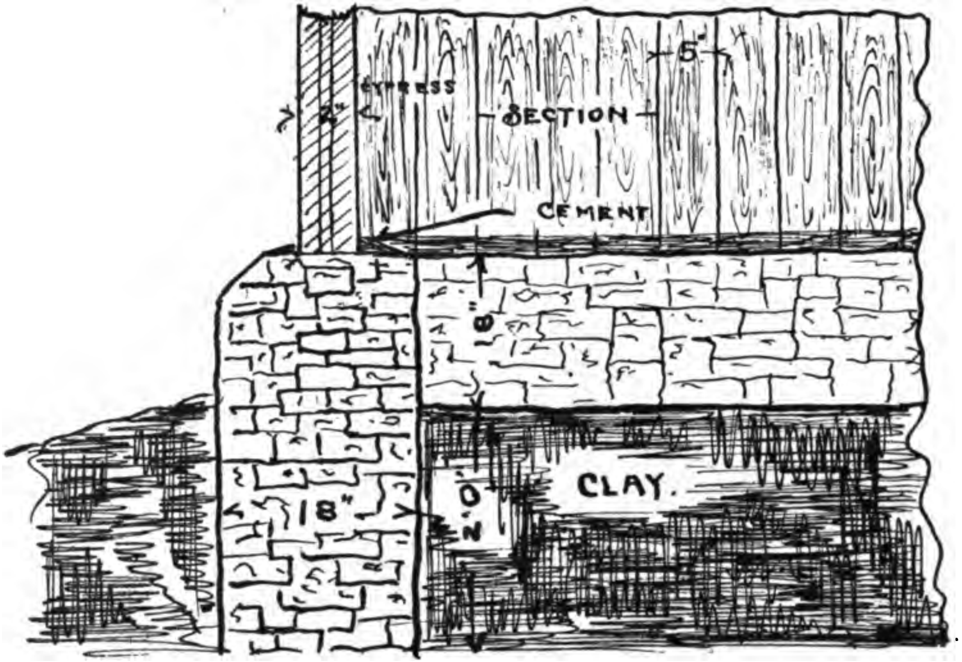
1. Silo on the farm of Mr. Reuben Sayler, Union Bridge, Carroll Co. Purchased round silo, 14′x29′= 100 tons, requires 7 acres to fill, feeds 8 head cattle. Cypress wood, tongued and grooved. Constructed in two sections with 6-inch iron band at joint. This is not air tight and silage spoils at that point. See sketch No. 1 and cross section No. 1.

2. Silos of Mr. Samuel Diehl, Union Bridge, Carroll Co. Kalamazoo round silos, 10′ x 30′ = 43 tons, cost $100, and 12′ x 30′ = 67 tons, cost $120. Feeds 25 head cattle. Stone foundation 2 feet below ground and 6 inches above ground (see sketch No. 2) required 5 and 6 perches stone. 2″ x 6″ cypress wood, tongued and grooved. Painted with gas tar on inside, not considered advisable. Age of silo 5 years.

3. Silo of Mr. Louis Messler, Union Bridge, Carroll Co. Smith and Reifsnider round silo 14′ x 30′, cost $135. Feeds 15 head cattle. Staves,

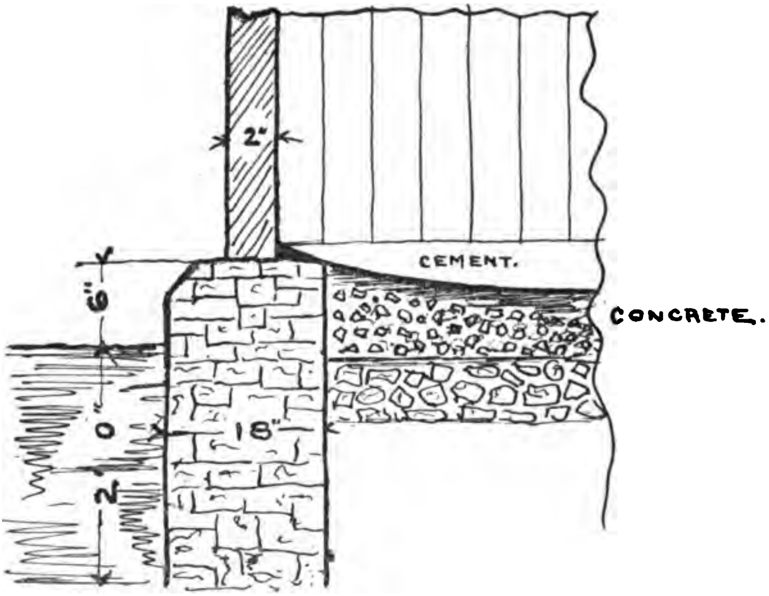


Sketch of Barn and Silo No. 1.



Foundation Construction of Silo No. 1.

cypress wood, tongue and grooved. Stone foundation (10 perch) 2′ 6″ in ground, 12′ above ground. Cost to fill $60 to $75. Outside of silo painted—age 5 years. Uses white field corn for silage. Foundation same as No. 2. Mr. Messler, considers silage unprofitable for cows and has discontinued its use and sold the silo. The iron splices in the staves of the silo had rusted out and the ends of the staves decayed when torn down.

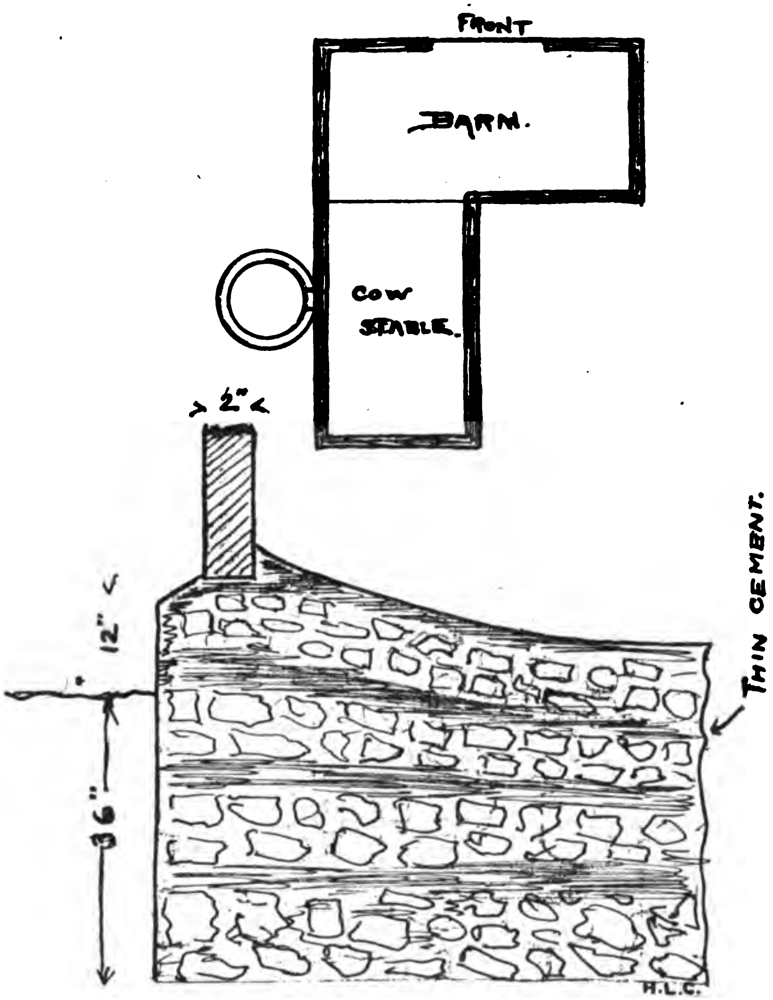


Foundation Construction of Silo No. 2.

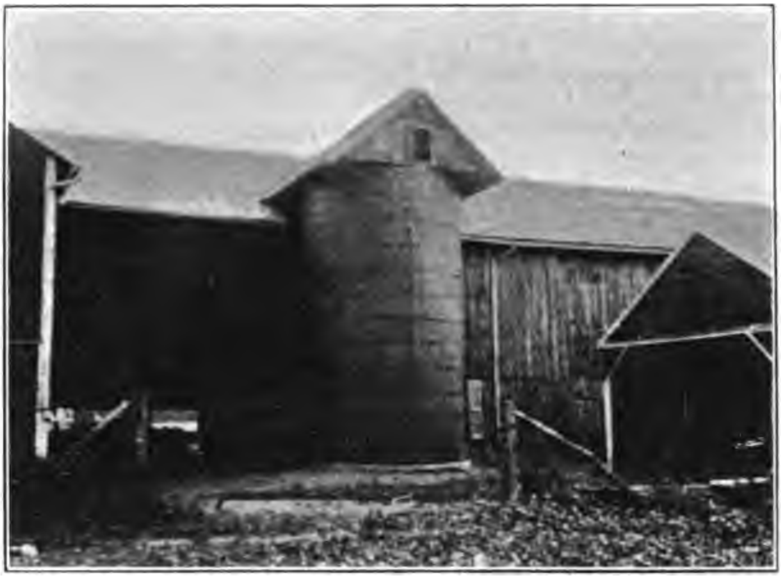
4. Silo of Mr. Thaddeus Starr, Union Bridge, Carroll Co. Economy (Frederick) round silo, 14′ x 24′ = 75 tons, cost about $200. Feeds 20 head cattle. Staves 2″ x 6″ white pine wood, tongue and grooved—concrete foundation 2 feet in ground, 1 foot above. Given a coat of red paint on outside each year—age three years. Grows white field corn and requires 6 acres to fill. This is a well-constructed silo, no leaks between foundation and staves, giving good satisfaction. See sketch No. 4. Note style of roof and method of tying silo to barn in photograph No. 4.

5. Silo of Mr. John Stultz, Union Bridge, Carroll Co. Home-made combination, stone and stave, 11′ x 22′ = 35 tons, cost $60. Feeds 10 head cattle. Staves, rough hemlock, 2″ x 6″—20′ (66 staves = 1320

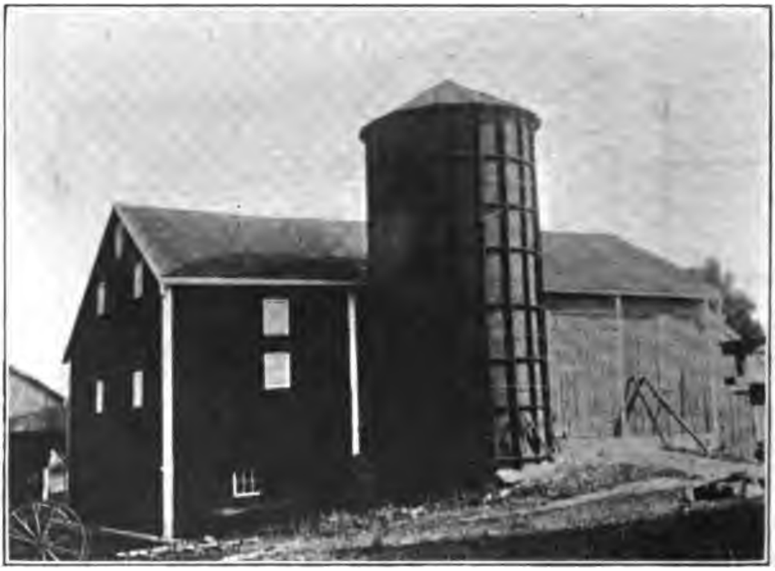
ft). Foundation 2 feet below ground, 18 inches above (6 perch stone). Grows white field corn and requires 3½ acres to fill. Age 1 year. This silo was economical to build, the 2 x 6 rough hemlock was purchased of the local lumber yard. Hoops of ⅝" iron were bent by the tire bender at the smith shop, and hoop lugs were purchased from the Chicago House Recking Co. There are a number of this kind of silos in the neighbor-



Showing Foundation Construction and Location of Silo No. 4.



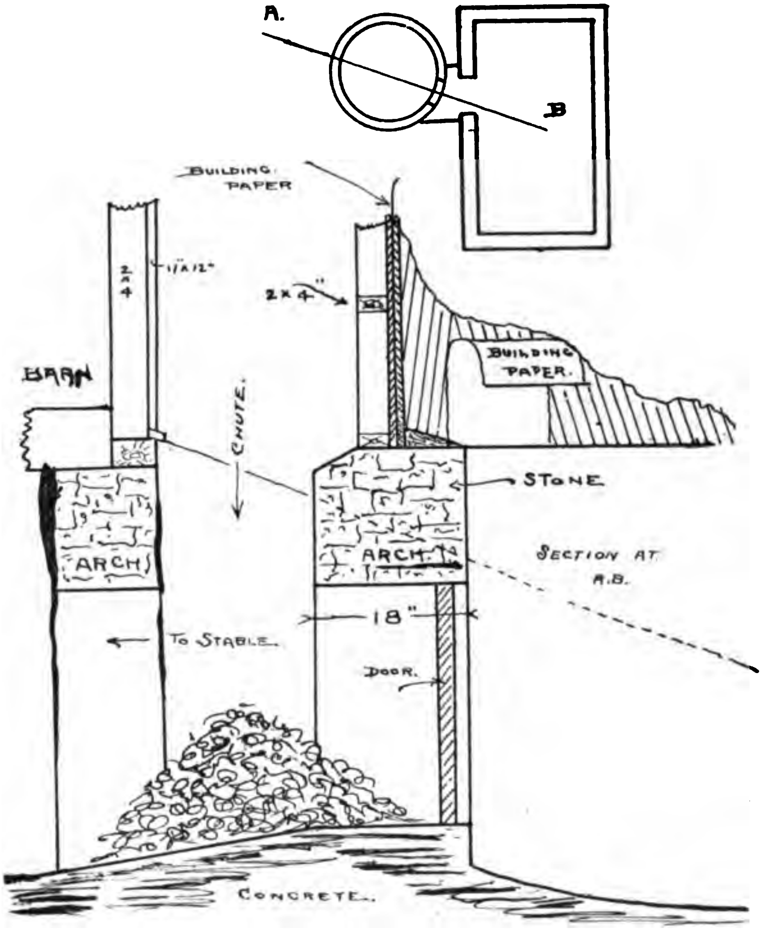
No. 4. Silo of Thaddeus Starr, Union Bridge, Carroll Co.



No. 6. Silo of Thos. J, Haines, New Windsor, Carroll Co.

hood of New Windsor and they are reported to preserve silage perfectly. For foundation see sketch No. 2, and for door see sketch No. 6.

6. Silo of Mr. Thos. J. Haines, New Windsor, Carroll Co. Homemade round silo. Combination of stone 6 feet and frame 22 feet. Size 12′ x 30′ = capacity 75 tons, cost about $200. Construction—stone foundation 18″ thick, 7 feet below ground and 1 foot above (19 perches). Wood frame of 2″ x 6″ Virginia pine with iron hoops, lined with two thickness of ⅞″ x 2″ Virginia pine flooring put on spirally. The spiral of each layer running in the opposite direction. Building paper between



Showing Some Details in the Construction of Silo No. 6.

the layers of flooring. For details of construction see photograph No. 6 and sketch No. 6. Painted red on outside. Required 4 men two weeks to build. The only silo of this construction found. The owner would not build another frame like this one. Uses Cuban Giant white silage corn and requires 5 to 6 acres to fill the silo. In use 4 years.

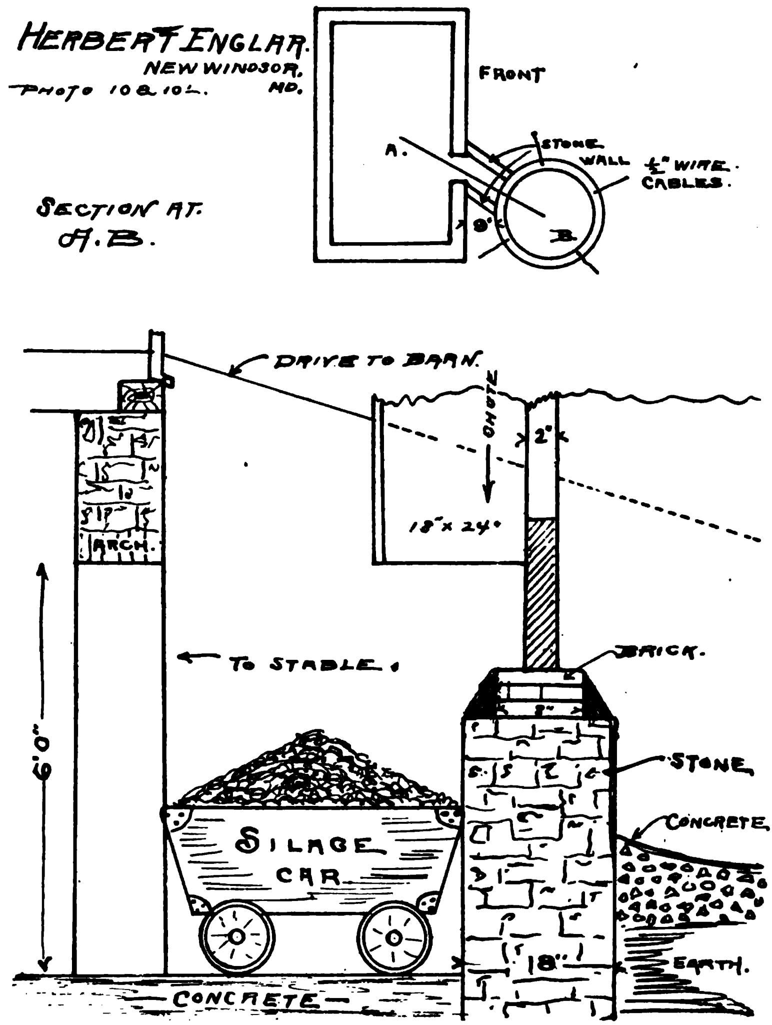
7. Silo of Mr. Herbert Engler, New Windsor, Carroll Co. Economy (Frederick) silo 14′ x 38′, with 2 ft. space in foundation giving a total depth of 40 ft. = 125 tons. Foundation 2 feet below and 2 feet above ground, required 11 perches stone. Staves 2″ x 5″. Painted red on outside. See photograph and sketch.

No. 7. Silo of Herbert Englar, New Windsor, Carroll Co.

8. Silo of Mr. Wm. Hesson, New Windsor, Carroll Co. "Economy" silo. Combination stave and stone. Frame 16′ x 30′, cost $308. Masonry (stone 25 perches) 16′ x 8′, cost $75. Total 16′ x 38′ = 160 tons, cost $383. Uses white field corn. Feeds 20 head cattle. 1 year old. Chute 18″ x 24″. Contains door and window. See silo in course of construction, photograph No. 8. For details of construction see sketch No. 7.

9. Silo of Joseph Engels, New Windsor, Carroll Co. Home-made combination stone and stave silo, 16′ x 27′ = 105 tons. Cost $85. Feeds 18 head stock—requires 5 or 6 acres to fill. Material required, 22

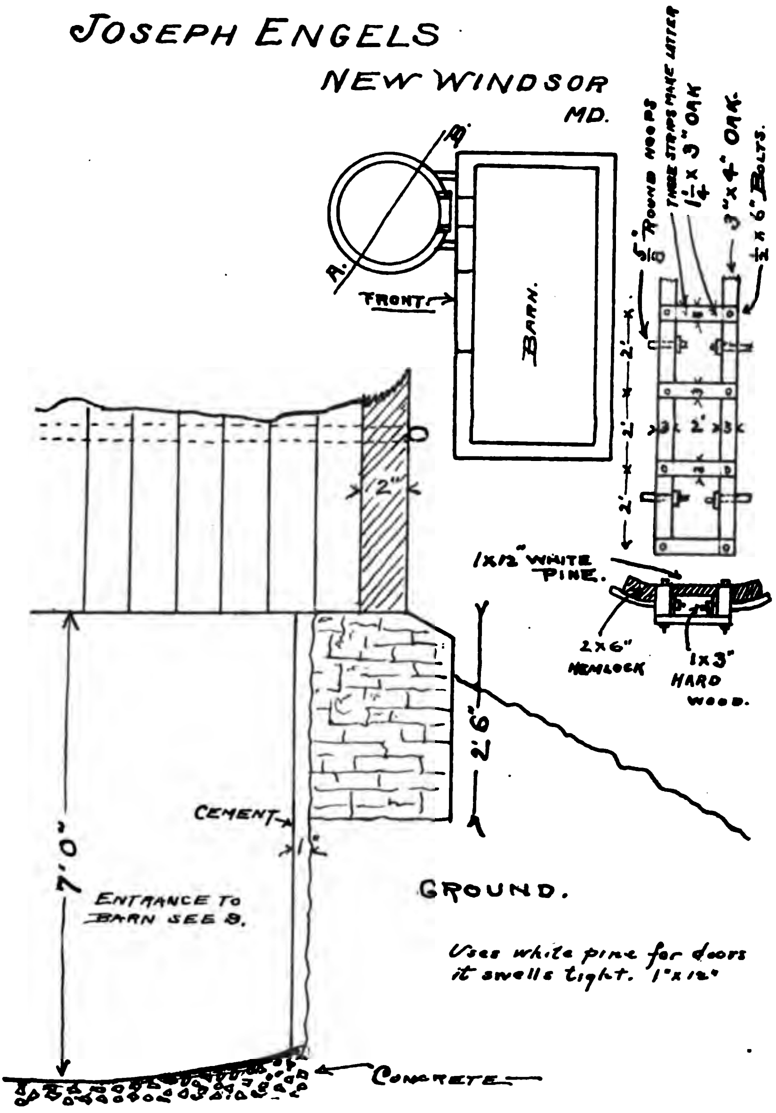
perches stone—96 staves 2" x 6", 20 feet long, or 1920 feet, ⅝" round iron hoops. Staves beveled on saw. Uses doors made of 1" x 12" white pine as it swells tight easily. Uses tar paper over doors. Shed roof hinged. Requires 15 to 18 men to fill in one day. Silo in use 7 years. See photograph and sketch No. 9.



Showing Some Details in the Construction of Silo No. 7.

No. 8. Silo of Wm. Hesson, New Windsor, Carroll Co.

No. 9. Silo of Joseph Engels, New Windsor, Carroll Co.



Showing Details of the Construction of Silo No. 9.

10. Silo on farm No. 1 of H. H. Devilbiss, New Windsor, Carroll Co. Smith and Reifsnider stave silo, 12′ x 30′ = 70 tons, cost $174. Foundation stone, 2 feet below and 1 foot above ground, required 12 perches. See sketch No. 2 for style of foundation.

11. Silo on farm No. 2 of H. H. Devilbiss, New Windsor, Carroll Co. Home-made combination stone and stave, 14′ x 30′ = 92 tons, cost $87. Foundation stone (27 perches), 9 feet below and 1 foot above ground. 84 staves, 2″ x 6″, 20 feet long, rough hemlock beveled (total 1680 ft.) ½″ dowels used, placed 3 feet apart. Wood not painted. Feeds 18 head cattle, requires 6 to 7 acres to fill, uses regular field corn. Silo in use 4 years. This silo has proved just as satisfactory as the one on farm No. 1. See sketch No. 6 for foundation and photograph No. 11.

No. 11. Silo of H. H. Devilbiss, New Windsor, Carroll Co.

12. Silo on farm of Mr. C. Carlisle, New Windsor, Carroll Co. Home-made combination silo, 14′ x 30′ = 92 tons, cost $90. In use 3 years, requires 7 acres to fill same as silo 11. Silo 9, 11, 12 which are of practically same construction have proven very satisfactory to their owners.

13. Silo of Daniel Englar, New Windsor, Carroll Co. Home-made combination silo, 12′ x 29′, cost $85. Foundation brick (3500) 6 inches above and 8 feet 6 inches below ground. 73 staves 2″ x 6″, 20 feet rough

hemlock (1460 ft.). Painted red annually. Silo in use 4 years. Feeds 10 head cattle. Silo keeps silage well, very ripe corn makes best silage. Uses tar paper around doors.

14. Silo of Mr. A. P. Snader, New Windsor, Carroll Co. Homemade combination 12′ x 25′. Foundation stone (12 perches) 1 foot above and 4½ feet below ground. 73 staves, 2″ x 6″, 20 ft. rough hemlock, beveled. Used dowel pine. Requires 7 acres of corn to fill—keeps silage very well. Silo in use 6 years and is in good state of preservation.

15. Silo on farm of Louis Green, New Windsor, Carroll Co. All data same as No. 12. Except foundation extends 3 feet above ground and the value of this is noticeable in the ends of the staves being very well preserved.

16. Silos on farm of Mr. Solomon Ecker, New Windsor, Carroll Co. 2 rectangular, 12′ x 20′ x 29′ silos. Depth of frame 14 feet, depth of stone 15 feet. Material used 60 perches stone, 50 pieces 2″ x 4″ x 14′ studding, 4 corner posts, 6″ x 6″ x 14′, 1000 feet 1″ x 12″ and 3000 feet 1″ x 6″. Height of foundation above ground 3 feet. Woodwork whitewashed. Silo in use 22 years, well preserved. Feeds 50 head cattle. See sketch.

This combination silo is on the farm of the late Solomon Ecker. It is said to have been built in 1885, constructed of stone and wood. Originally it was 12′ x 20′ with square corners. The silage spoiled in the corners and the surface was too large, so the silo was divided into two, as shown on the plan. A frame was constructed giving round corners with a radius of two feet. This allowed a hiding place for rats which destroyed these corners.

These combination silos preserve the silage better below the woodwork. This is due to the joint between the stone work and woodwork not being air tight.

The silage is removed from one, then passed from the other into the empty one and from it to the stable.

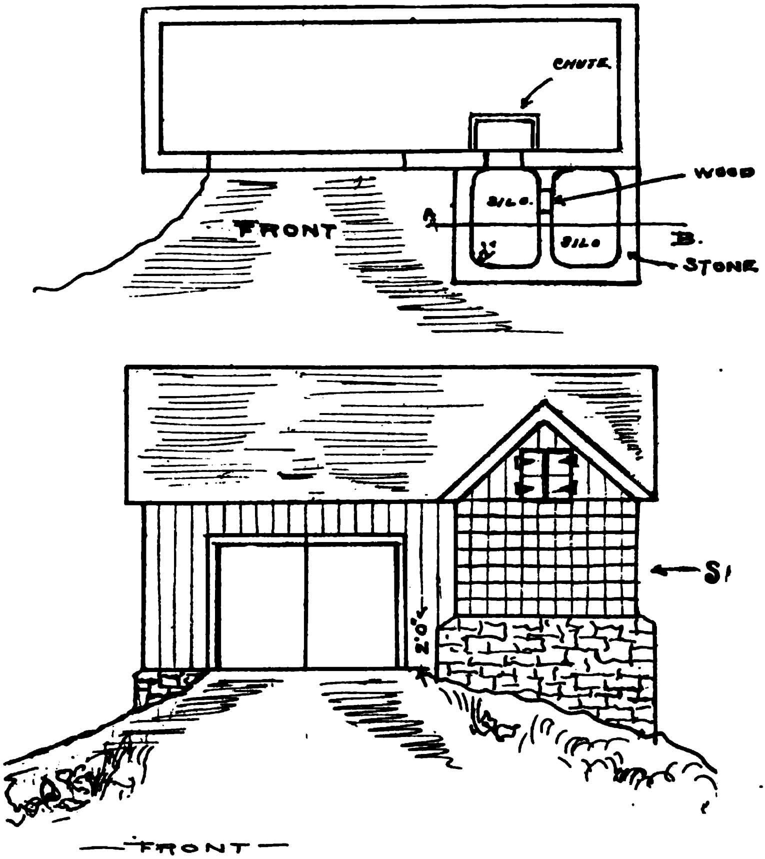
This silo is in good state of preservation, although it is 22 years old. Dampness causes cement to drop off and the stone work has to be patched occasionally.

Eight feet of silage remained at end of season, 6 inches was removed and refilled. This silage was good when used the latter part of the following year.

This was the second silo erected in this section, Elsworth Ecker, his brother, erected the first one.

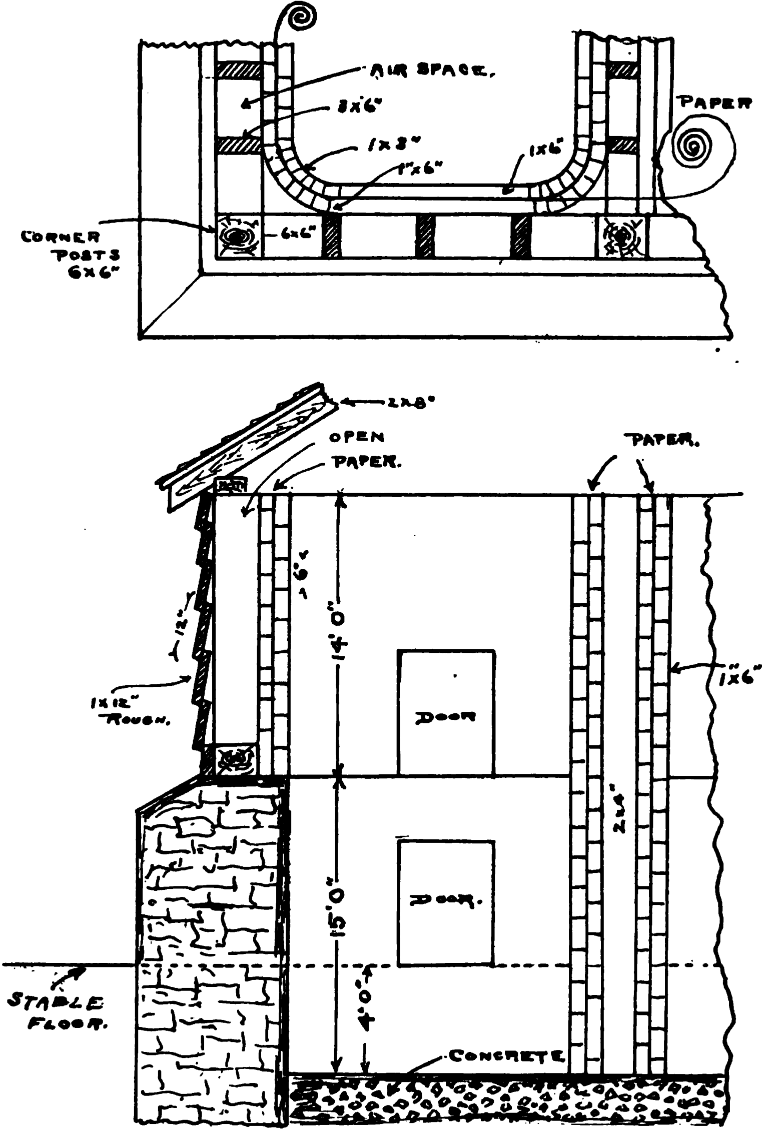
17. Silo of Mr. Elsworth Ecker, New Windsor, Carroll Co. Rectangular combination, 8′ x 28′x 12″, 6 feet below and 6 feet above ground. See sketch No. 17.

This silo was filled for 18 years, the 19th year did not have enough corn to fill, so it was cut and dried and he has been using it that way ever since, with good results.



No. 16. Silos of Solomon Ecker, New Windsor

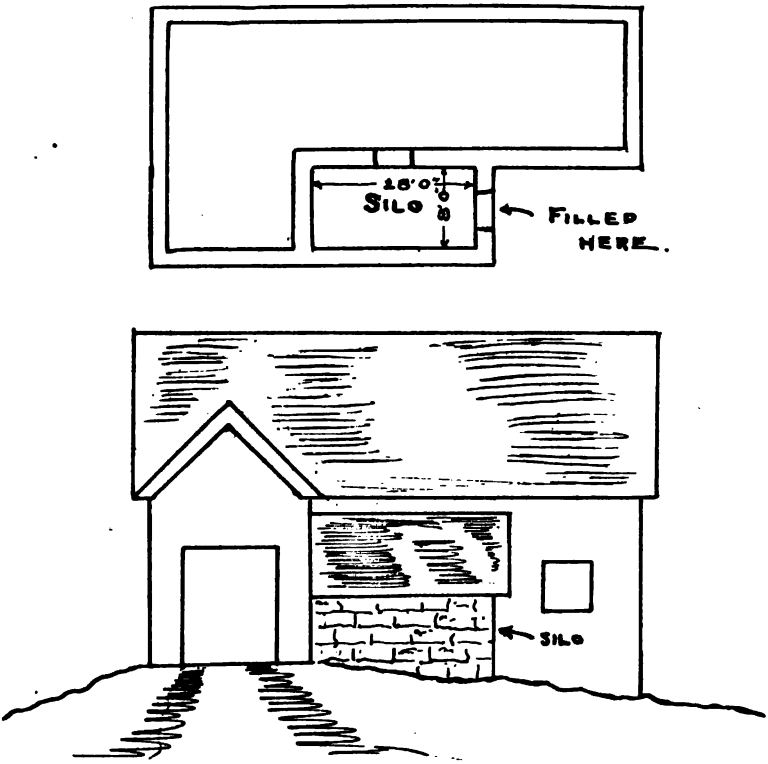
This is said to be the first silo in this section of the country. He previously buried the corn in pits in the ground 6′ x 12′, 5 ft. deep, using boards and dirt to cover; this kept well. This is a dry well-drained soil and the deeper it was buried the better it kept.



Showing Details of the Construction of Silos No. 16.

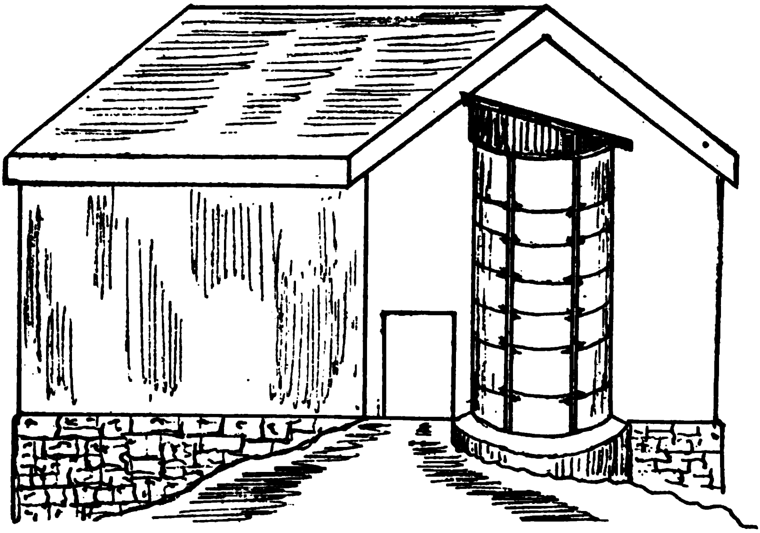
18. Silo on farm of Mr. N. Zile, New Windsor, Carroll Co. Combination round silo, 10′ x 28′, cost $60. Foundation stone (16 perches), 1 foot above and 8 feet below ground. 61 staves 2″ x 6″ rough chestnut (1220 ft.). Requires 4 acres sugar corn (no ears) to fill. Feeds 8 head cattle. In use 3 years.

This silo is constructed like the Smith and Reifsnider silos. There are two staves, 4 x 4 oak. The hoops run through these staves and tighten with a nut, the hoops are in three sections. This silo is in good shape, the chestnut is free from knots and swells, making the silo tight. See sketch No. 18.

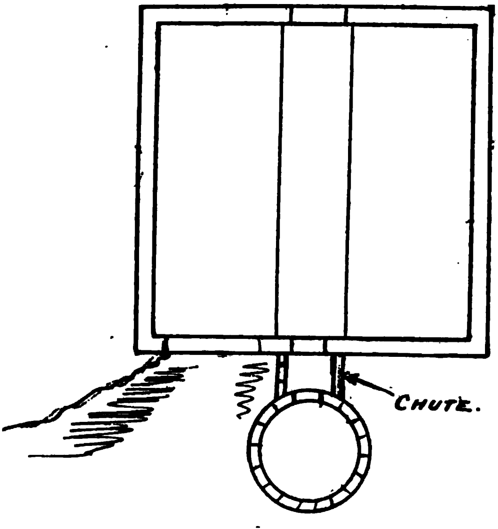


Showing Silo No. 17.

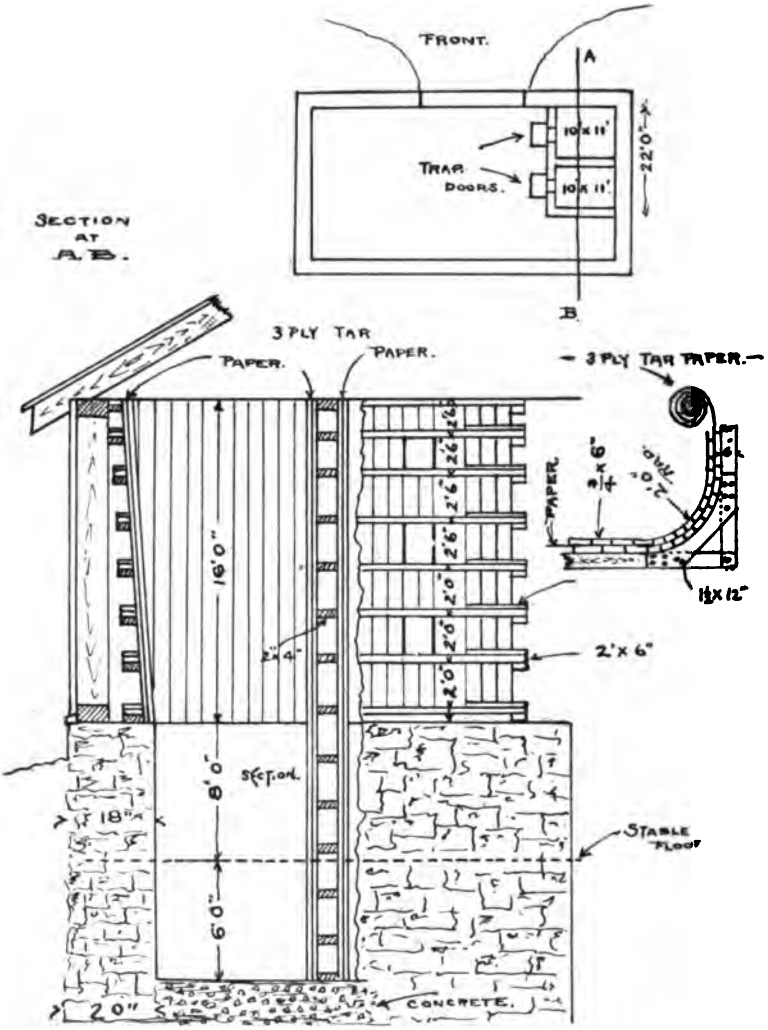
19. Silos of Mr. Jonas Wagner, Medford, Carroll Co. Two rectangular combination silos, 10 ′x 11′–30′, built in barn. Frame construction 24 feet, and masonry 6 feet below ground, cost $65. Requires 5 to



Showing Elevation of Silo No. 18.



Cross Section of Silo No. 18.



Showing Location and Construction of Silos No. 19.

6 acres to fill and takes three men and one boy three days. Keeps silage well. Silo in use 9 years and all parts seem as good as new.

This was built as one silo and a partition put in later. Two sides only are tapered to cause silage to pack, the other sides are perpendicular.

When pit is sunk in ground it must be water proof, if pit fills up with water it spoils silage. Where pit fills with water it is necessary to put in blind ditch. If this cannot be done, and it is impossible to prevent pit from filling with water, the pit will have to be filled to the point where water drains. A lining of good Portland cement will make pit water proof, providing the stone work extends high enough to prevent surface water from flowing in.

Those who have tried silos with a water proof pit find that a silo without a roof causes the pit to fill with water from the rain and snow and the silage is not as good in the pit. Only two without roofs have been found so far and their owners were going to put them on.

Ninety per cent of the stave silos are not air tight at the foundation, the shrinking and swelling of the staves break the cement, thus allowing air to get in and the excessive amount of water to run out. The silage decays from the air being admitted, but does not sour from excessive water, as the water escapes. There is no difference in the silage taken from the top or bottom, that is, when there is no pit. This kind of a silo does not need a roof, but if the air is excluded at the foundation as it should be a roof is essential, or the silage will be slimy and the bottom will not be as good as the top. See sketch No. 19.

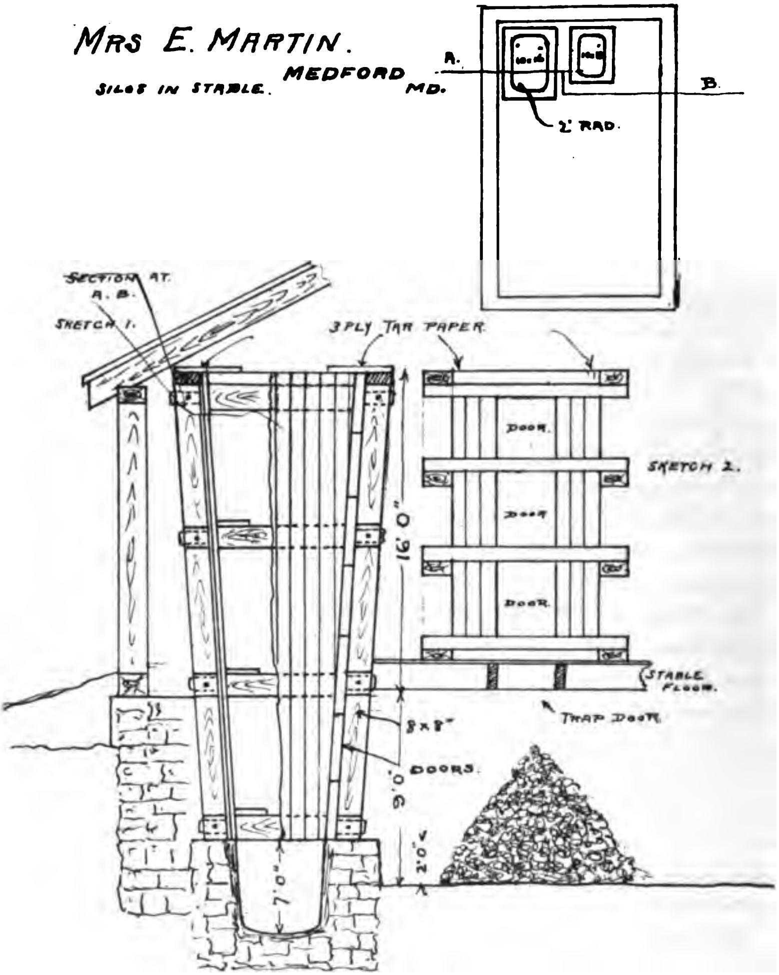
20. Silos of Mrs. E. Martin, Medford, Carroll Co. 2 rectangular combination silos, 10′ x 16′ x 35′ and 10′ x 12′ x 35′, built in barn. Frame construction, 28 feet, and masonry, 7 feet, masonry extends 2 feet above cow stable floor. Silos are narrower at bottom than at top. See sketch No. 20. Silos in use 7 years and in good condition. Keep silage well, but this form would not be built again.

21. Silos of Mr. Ephraim Haines, New Windsor, Carroll Co. 2 round silos, 14′ x 32′. Feeds 25 head cattle. Foundation 2½ feet below ground and 6 inches above. This makes the staves too close to the ground and they are decaying; in use 7 years. See photograph No. 21.

22. Silo of Mr. Frank H. Willet, Medford, Carroll Co. Purchased stave silo in combination with stone, masonry 12′ x 10′, stave portion 12′ x 20′, or total 12′ x 30′. Doors 2 feet apart and 2 feet square. Foundation same as sketch No. 6.

23. Silo of Mr. Ernest Meyers, Medford, Carroll Co. Home-made combination wood and stone silo, 14′ x 35′, 84 staves 2″ x 6″, rough

chestnut (total 1680 ft.). Foundation brick (11,500) 1 foot above and 14 feet below ground. Requires 5 acres and 15 men 2½ days to fill. Feeds 15 head cattle. In use 4 years. Tin roof. Rabbit for doors is beveled and door has corresponding bevel. Paper is used around the interior of silo when filling.



Showing Location and Construction of Silo No. 20.

24. Silos of Mr. Henry Castles, Medford, Carroll Co. Silo No. 1, stave and stone combination, 14′ x 33′ (staves 28 ft.) 5 years old. Silo No. 2 stave 14′ x 28′, 3 years old. See photograph No. 24.

Mr. Castle built one silo and found that he did not have enough silage; he then constructed a second one and found that he had too much. He fed the cows all they could eat, covered with bran and cottonseed meal, three times a day. The cows decreased in their milk yield and were in a poor condition in the spring. His cows consumed 5 or 6 tons of bran in one year, no long feed having been fed.

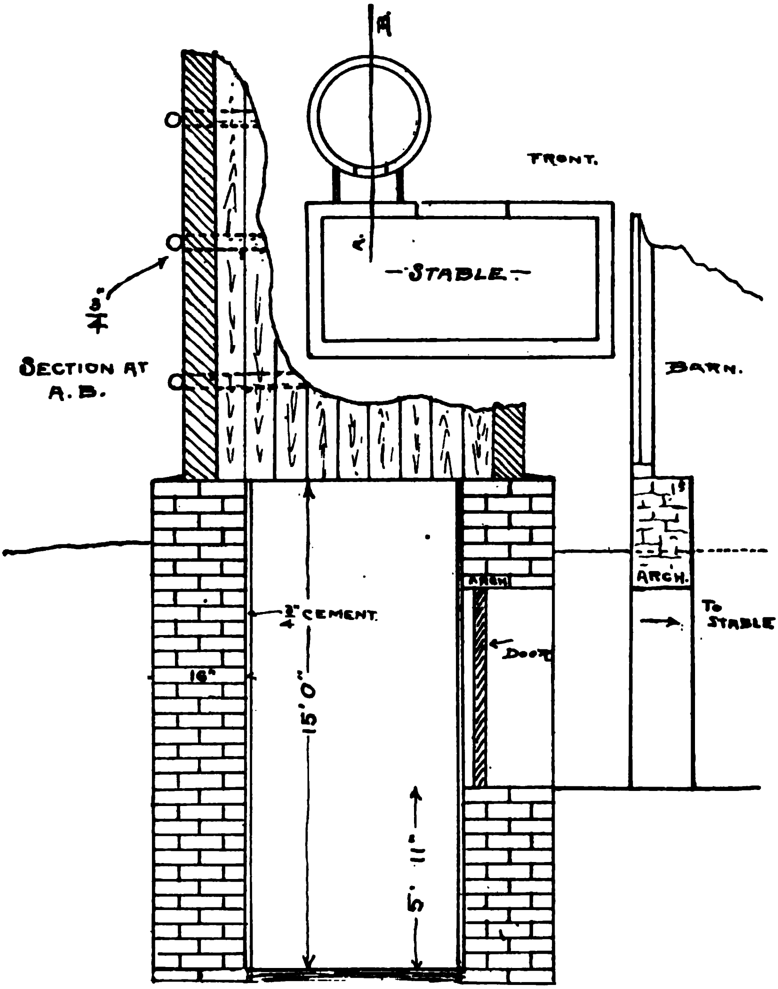
The following year he shucked his corn, getting 100 barrels of corn and 750 bushels of chop, and fed the fodder. He not only increased the milk yield, but the stock were reported to have been in a beautiful condition

No. 21. Silo of Ephraim Haines, Medford, Carroll Co.

The spoiling of the silage in these silos was due to a poorly constructed foundation.

25. Silo of Mr. Joshua Gist, Westminster, Carroll Co. Smith and Reifsnider, stave silo, 16′ x 30′. Feeds 30 head cattle. For foundation see sketch No. 4. See photograph No. 25.

This foundation is two feet above ground, therefore the staves have not decayed at the foundation. This silo is painted with white lead and presents a beautiful appearance. The inside is kept perfectly clean, and it preserves the silage well.



Showing Cross-section of Silo No. 23.

No. 24. Silos of Henry Castle, Medford, Carroll Co.

No. 25. Silo of Joshua Gist, Westminster, Carroll Co.

26. Silo of Mr. William Roop, Westminster, Carroll Co. Combination stone and stave silo, 14′ x 38′, cost $175. Stone foundation (21 perch), 1 foot above and 7 feet below ground. Painted red on outside, 5 years old. Feeds 18 head cattle.

Mr. W. Roop superintends the placing of the fodder when filling and he said this accounts for his not having any silage to spoil. He is able to keep his cows in as good condition as when he did not use silage, and gets more milk from the use of silage.

27. Stacked silage of B. F. Shriver & Bro., Canners at New Windsor, Westminster and Union Mills. See photograph No. 27.

They run the canning refuse through the silage cutter and alternate layers of ground corn cobs and corn husks, and put in large stacks about 20′ x 40′ x 12′ high. It sours to a height of 24 inches from the ground and spoils 12 inches around the circumference. The loss is very great, and the stock do not eat the 24 inches mentioned with a relish. Mr. Shriver said they could afford to allow this portion to spoil as they had an enormous quantity of the silage, but, if he were growing silage under the same conditions as the ordinary farmer he would use silos. Silage use for fattening cattle. Feeds 200 to 400 head each year.

28. Silo of Mr. Wm. H. Geisman, Westminster, Carroll Co. Smith and Reifsnider, stave silo, 12′ x 24′, capacity 50 to 75 tons. Requires 4 to 5 acres to fill. Feeds 14 head cattle. Foundation same as No. 2.

This silo and many others are out of round due to the hoops not being in one piece. The short hoops which draw on the extra thick staves flatten the silo between these staves. Litter in barn yard has decayed this silo at the foundation. He has obtained better results in feeding from the use of silage.

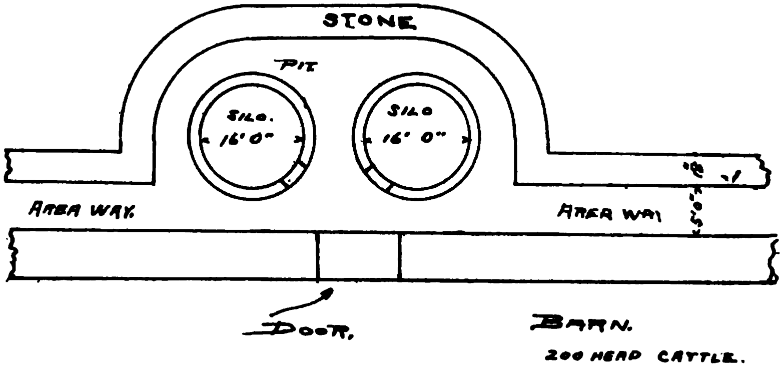
29. Stone silo of Mr. Chas. A. Councilman, Glyndon, Balto. Co. Round stone silo, 20′ x 32′, cost $500, 12 feet below and 20 feet above ground. Walls 2 feet thick. Built from lime stone quarried on the farm. Required 160 perches of stone. Keeps silage well. See photograph No. 29.

30. Rectangular silos of Mr. Chas. A. Councilman, Glyndon, Baltimore Co. Two square silos in barn, 12′ x 18′ x 25′. Pit is 15 feet with 10 feet of wood work, making a total of 25 feet. The silage is hoisted out with a block and tackle and removed from two doors in the frame part of the silo. The frame work is built of 8″ x 8″ corner posts and 4″ x 4″ ties lined on inside with two thickness of lumber with tar paper between. The silage does not keep well in the square corners. Uses corn and cowpeas grown in combination for filling the silos.

No. 27. Stacked Silage.

No. 29. Stone Silo.

31. Silos of Mr. A. W. Fuss, Worthington Valley, Baltimore Co. 2 Smith and Reifsnider stave silos, 16′ x 30′. Feeds 200 head beef cattle. In use 6 years. Foundation 12 inches above ground. Mr. Fuss excavated and formed a circular cavity in front of his barn and placed two 30 feet silos in this excavation. He claims that the silage settles perfectly in a straight stave silo, and that the walls in a combination silo prevent this and causes the silage to spoil. He never has any silage to spoil. The silage is placed in the silo, saucer shaped, and stamped. Eight inches of very green corn cut and placed on top will seal perfectly. See sketch No. 31.



Showing Location and Construction of Silos No. 31.

32. Silo on farm of Mr. J. M. Gardner, Worthington Valley. Stave silo, 12′ x 28′, in use 3 years. Foundation above ground 12 inches and staves show evidence of decay. This silo was without a roof. The superintendent of this farm said that the rain turned the silage dark and the removal of snow caused additional labor and that he was going to put a roof on before refilling. See photograph No. 32.

33. Silos of Mr. S. M. Shoemaker, Eccleston, Baltimore Co. Two Kalamazoo stave silos, 14′ x 32′; two Kalamazoo stave silos, 16′ x 28′ and one Philadelphia stave silo 16′ x 40′.

These silos are mechanically constructed, a concrete pavement surrounds the group, affording a clean surface which allows the spilt silage to be taken up; it also furnishes a perfect drain.

Two of the Kalamazoo silos have a five foot pit, the silage taken from the pit is sourer than those having no pits.

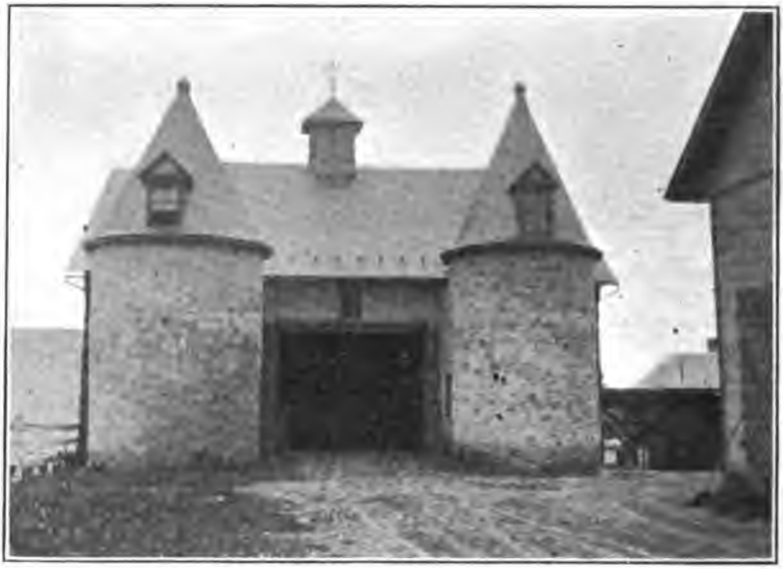
Those having no pits are built like No. 2. Those with pits are built of stone lain in cement; silage is thrown out.

No. 32. Silo of J. M. Gardner, Worthington Valley, Baltimore Co.

No. 33. Silos of S. M. Shoemaker, Eccleston, Baltimore Co.

One of the 14′ x 32′ Kalamazoo silos is lined with brick laid the four-inch way, and the brick is lined with cement. This silo is a good keeper, but will not stand when staves decay. The gain in keeping does not justify the expense.

34. Silos on the farm of Mr. Harry D. Hanway, Belair, Harford Co. No. 1, stone silo, 14′ x 30′. No. 2, stone silo 12′ x 30′, walls 2 feet thick, in use 8 years. See photograph No. 34. No. 3, Philadelphia stave silo, 18′ x 30′ with foundation like sketch No. 2. This silo is in the barn, and keeps better than the stone ones. The stone sweats on inside and silage spoils around the edges. The stone silos are built in front of the barn, one on each side of entrance; there is a 12-inch revolving ventilator on each one. These silos extend to bottom floor of stable and have two small doors 2′ x 2′, and a large door at the bottom entering stable.

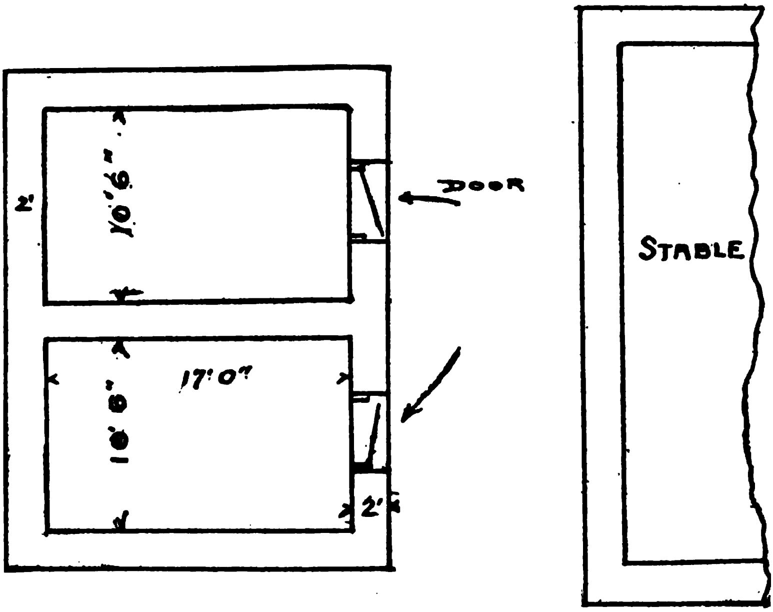


No. 34. Silos of Harry D. Hanway, Belair, Harford Co.

35. Silo of Mr. David Hanway, Bel Air, Harford Co. Square stone silo, 12′ x 12′ x 24′, walls 18″ thick, estimated cost $150. Mr. Hanway does not believe that stone silos are the best preservers of silage, and is going to construct a new silo of wood, 16′ x 16′ and 26 feet high. This silo is to have a stone foundation but it is not to be a combination silo.

36. Silos of Mr. Henry Burns, Bel Air, Harford Co. 2 rectangular stone silos, 21′ x 27′ x 18′ (divided into 2 silos, see sketch and photograph), walls 2 feet thick. Silo is 12 feet above and 6 feet below ground. In use 7 years.

This silo has a stone partition making two silos 12½′ x 17′ x 18′. There is one door in each silo opening under shed (see photo). These silos are filled every year. Mr. Burns is a dealer in stock, and finds silos profitable to stock raisers. These silos preserve the silage with but little decay.



Floor Plan of Silos No. 36.

37. Mr. William Grant, Bel Air, Harford Co., uses a 12′ x 26′ Philadelphia silo, set on a foundation that gives 4½ feet of a pit. In use 3 years, feeds 18 head cattle. Reports the silage not as good from the stone as from the wood portion.

38. Silo of Nathan Oldfield, Bel Air, Harford Co. Philadelphia stave silo, 16′ x 30′, with 8 ft. pit. Note roof construction as shown in photograph No. 38.

39. Silo of Mr. P. H. McCormick, Bel Air, Harford Co. Square stone silo constructed in end of barn, 15′ x 15′ x 27′, walls 2 feet thick. In use 20 years. This silo has no opening except at top. They use a

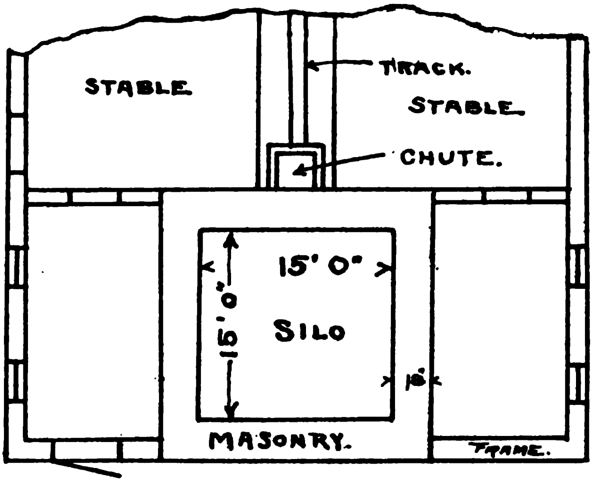
No. 36. Silo of Henry Bruns, Belair, Harford Co.

No. 38. Silo of Nathan Oldfield, Belair, Harford Co.

sugar barrel rigged on a hay rope similar to a hay fork, for removing the silage. The silage is better at the bottom than at the top. There is a chute from the top of the silo to the stable, and silage is conveyed into a car on a track which is used in the stable, feeding from both sides of car.

The braces and rods seen in the photograph are to support the masonry which is cracked.

40. Silo of Mr. J. L. McCormick, Bel Air, Harford Co. Photograph No. 40 represents a square silo, 10′ below ground stone, 6′ above ground frame. Silo 10′ x 10′, square corners. The frame work is constructed of studding 3″ x 4″ lined on outside with 1″ x 12″ stock lumber and stripped. The inside is lined with rough board, interlined with tar paper, and horizontally lined with ⅞″ tongue and grooved yellow pine. The silage keeps well, but is best when removed to one foot below masonry. Great care must be taken when filling to prevent silage from spoiling in corners.



Showing Floor Plan of Silo and Stable. Silo No. 39.

41. Silo of Mr. J. L. McCormick, Bel Air, Harford Co. Sketch No. 41 represents a square silo 8′ x 8′ x 16′, three feet of which is above the ground. This is built of stone, the masonry is two feet thick. It has a gable roof and is filled with ice when silage is removed. This combination silo and ice house preserves the silage well, a small amount spoiling in the square corners.

No. 39, Silo of P. H. McCormick, Belair, Harford Co.

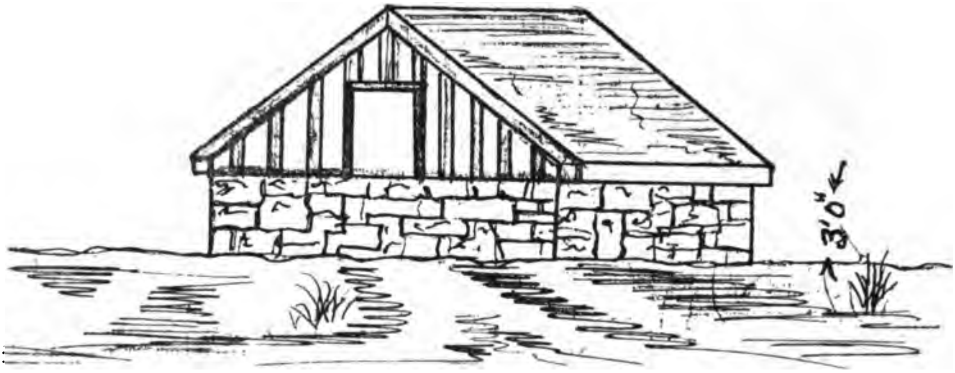
No. 40. Silo of J. L. McCormick, Belair, Harford Co.
(Silo is the low building near the fence.)

42, 43, 44 and 45. Silos on Filston Farm, Glencoe, Balto. Co. Photograph No. 42 represents on the left rectangular stone silo, 20′ x 60′. Abandoned on account of too much surface to spoil.

Round silo next to rectangular silo is 16′ x 30′, under same roof covering a 14′ x 30′ silo. These are manufactured silos, make not known. They are not true (round) due to being blown down and reconstructed. Foundation construction, see Photograph No. 2.

Photograph No. 43 represents two octagon-shaped silos, 18′ x 30′, 25 feet high, no pit. Saucer shape foundation of concrete.

These silos are said to preserve the silage well, but are not as good as the round as some spoils in the corners.

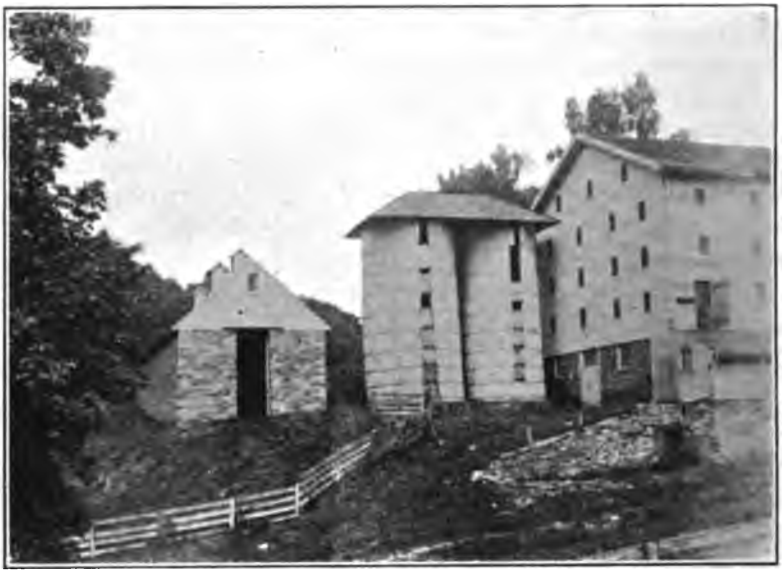


Sketch of Silo No. 41.

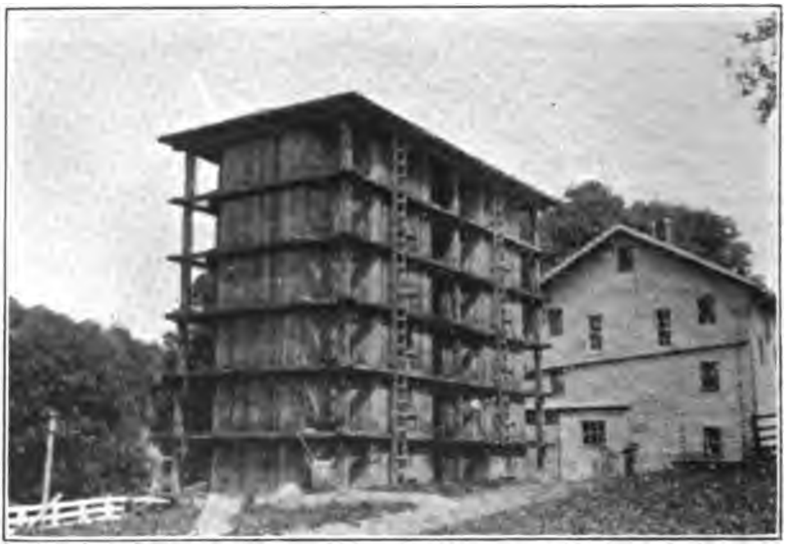
Corner and center posts are 8″ x 8″. Ties are 4″ x 8″ half-lapped. Two thicknesses of 1″ x 6″ rough yellow pine is used for lining with tar paper between. The joints are broken by placing inner lining three inches in advance. The doors are hinged vertically and open from inside. These doors lap at an angle of 60° in center; two doors to an opening.

Photograph No. 44 represents two Philadelphia silos, 16′ x 30′. Foundation stone, see Photo No. 2. These silos present a fine appearance and are said to be fine preservers of silage.

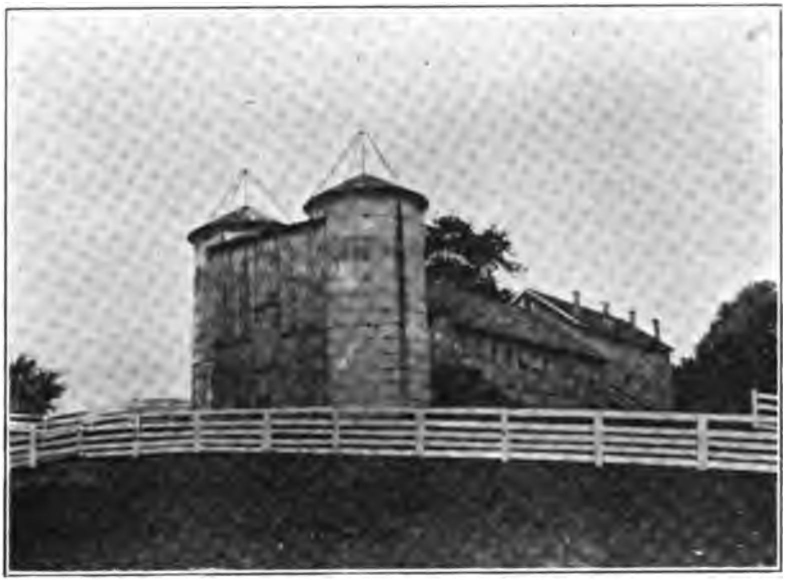
45. Two round silos stave, 16′ x 26′. They are built in the stable of 1″ x 12″ rough lumber used as vertical staves, with ¾″ round iron hoops placed 4 feet apart. These hoops are in two sections. The couplings for hoops were forged at the smith shop. Foundation concrete, see Photo No. 2. Each silo has three doors 3 feet long and 22 inches wide. These silos are good preservers of silage.



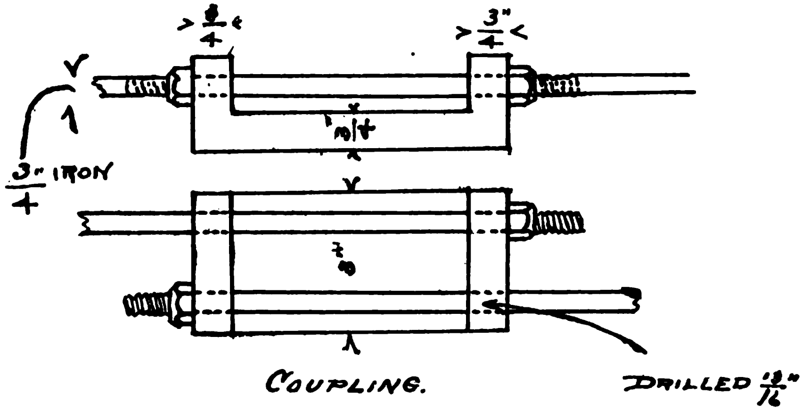
No. 42. Filston Farm Silos, Glencoe, Baltimore Co.



No. 43. Filston Farm Silos, Glencoe, Baltimore Co.



No. 44. Filston Farm Silos, Glencoe, Baltimore Co.



Couplings for Hoops for Silo No. 45 (forged at smith shop).

46. Silo of Mr. U. H. Tarbert, Glencoe, Baltimore Co. Photograph No. 46 represents a round stone silo, wall two feet thick. 16 feet in diameter, 24 feet visible in photograph, 8 feet to bottom of cow stable, 8 feet below bottom of cow stable, total height 40 feet. This silo preserves silage well. Built in 1899. Feeds 30 head cattle.

This silo was built partly in old barn which was destroyed by fire, the silo and its contents were well preserved, and new barn, which appears in photograph, was constructed around the silo.

47. Silo of Mr. L. M. Bacon, Monkton, Baltimore Co. Photograph No. 47 represents a square stone silo, 25′ x 25′ inside, and has round corners constructed with a two-foot radius. 15 feet above ground, 8 feet to bottom of cow stable and 7 feet below bottom of cow stable, making a total height of 30 feet. Seven years old, cost about $800, stone and farm labor not included. Requires 20 acres to fill. This silo is a good preserver of silage.

This is a fine piece of masonry. Walls are 2 feet at top, tapered to 2½ feet at bottom. Door from bottom to cow stable. Silage would have to be hoisted out if it was desired to have it all preserved, but they excavate a cavity from door at bottom to the top of the silage and then remove the top, passing the same down the excavation and deliver through door to cow stable. The silage on the edges of the excavation spoils from exposure, but the convenience justifies the loss. This is considered a bad practice as a series of doors would preserve the silage, but too many doors would weaken the masonry.

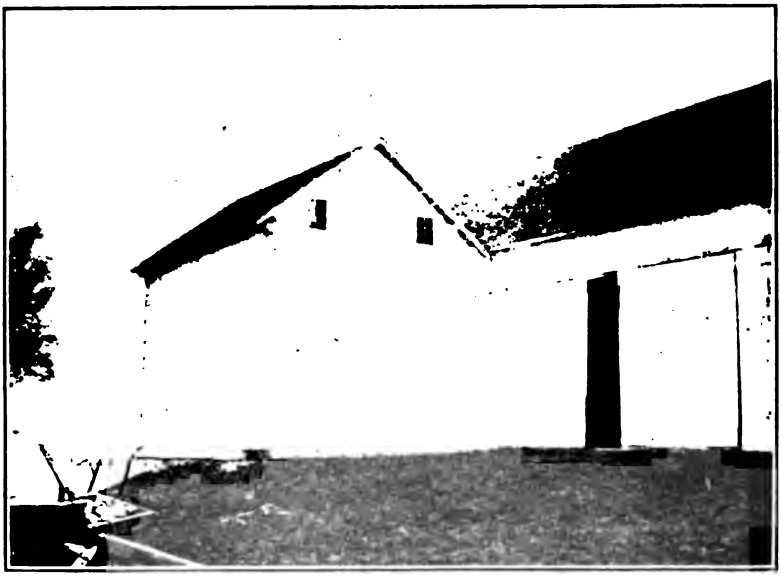
48. Silo of Mr. H. A. Mathews, Monkton, Baltimore Co. Buffalo, N. Y. stave silo, 14′ x 30′ on stone foundation with 10′ pit, giving a total depth of 40 feet. Same style of foundation as sketch No. 6. Cost about $250. Wood staves too near ground and are decaying. See Photograph No. 48.

49. Silo of Mr. W. H. Curry, Monkton, Baltimore Co. This is a rectangular combination silo, 22′ x 26′; 18′ frame, 9′ stone, making a total height of 27′. Corners are round with 2 feet radius. Built in 1892. The interior is lined with boards, double lapped, with lathes nailed vertically to receive lathes which are nailed horizontally. These lathes are plastered with cement, thus making a perfectly air tight silo which preserves the silage well. Three thicknesses of newspaper is lapped on inside of doors when filling. This was the only silo found built in this manner, except a round silo built by Mr. G. E. Shelly who adopted Mr. Curry's method of cementing. This is an excellent idea, but great care must be taken in removing silage, or the cement will be broken.

No. 46. Silo of U. H. Tarbert, Glencoe, Baltimore Co.

No. 47. Silo of Louis M. Bacon, Monkton, Baltimore Co.

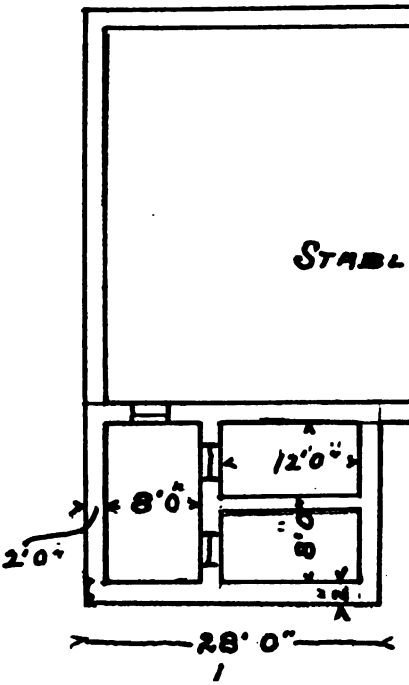
No. 48. Silo of H. A. Mathews, Monkton, Baltimore Co.



No. 49. Silo of W. H. Curry, Monkton, Baltimore, Co.

The silage is kept 12 inches in advance in the center of the silo when filling, this prevents the silage from spoiling on the sides.

Mr. W. H. Curry has the finest silage corn that was found in the state. Average height, 15 feet. Has from three to five ears on many of the stalks. It is planted with drill 13 inches apart in rows 3 feet 6 inches apart. This was the only silage corn that was found free from weeds and grass. See photograph No. 49a.



Showing Cross Section and Location of Silos No. 49.

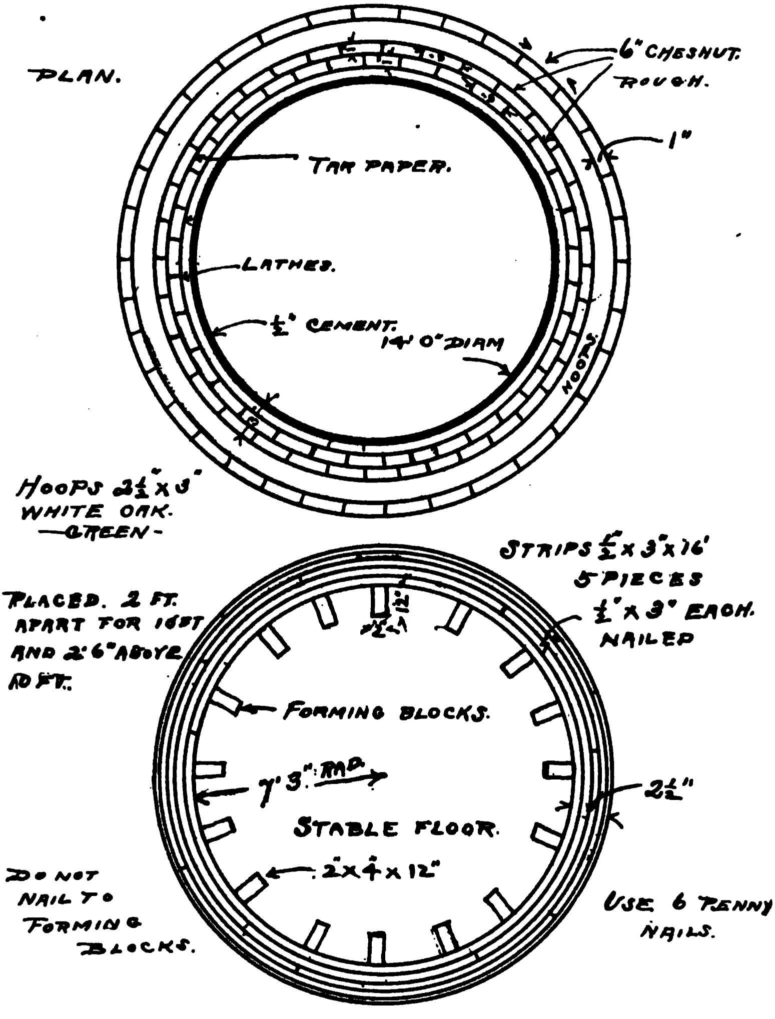
50. Silo of Mr. H. Nelson, Monkton, Baltimore Co. This is a round stone silo, 13′ above ground and 12′ below ground, making a total height of 25 feet. Diameter 13′ inside, 18-inch wall. This silo is a perfect preserver. There is a perfect fitting concave door on the level with ground which is the floor of his cow stable. Required 65 perch of stone.

51. Silo of Mr. Geo. E. Shelley, Monkton, Baltimore Co. Home-made combination stone and stave silo, 14′ x 28′ 20 ft. staves on an 8′ pit. Requires 5 acres to fill.

No. 49a. Silage Corn of W. H. Curry, Monkton, Baltimore Co.

No. 50. Silo of H. Nelson, Phoenix, Baltimore Co.

The staves on outside are chestnut, 6″ wide, nailed on vertically 16′ long, and 4′ nailed above. The four feet pieces are nailed on so as to lap on the 16′ pieces allowing the water to run off.



Showing Method of Making Hoops and Details of the Construction of Silo No. 51.

The interior is vertically lined with 6″ chestnut, tar paper placed, and again lined with 6″ chestnut, joints being broken, then the vertical lathes are placed, followed with horizontal and then plastered with cement. This is a perfect silo, the bottom is cemented in saucer shape. The construction is similar to T. J. Haines No. 6, except that board staves cover the outside and the inside is plastered. This silo is not affected by atmospheric conditions. The cement is not thick enough to cause it to sweat, and it is as perfect a preserver as the stone silo there being no decay from sweating. This manner of construction is the only perfect combination silo that was found. The stone and frame work remain flush, thus allowing the silage to settle evenly which is not the case in the stave silos, as the silo has to be placed in the center of the wall, if placed too near the pit the shrinkage will allow the hoops to pull the staves to a smaller diameter than that of the pit and thus cause a leak at the foundation, this unevenness allowing the silo to fall or blow over. Every other space between hoops is a door, paper is used between door and joint. Stave silos with hoops ought not to be used as a combination silo.

The following is a list of the material required:

150 P. ½″ x 3″ x 16′ white oak for hoops.

50 P. 1″ x 6″ x 16′ chestnut staves } outside.
50 P. 1″ x 6″ x 4′ chestnut staves }

50 P. 1″ x 6″ x 16′ chestnut staves } inside
50 P. 1″ x 6″ x 4′ chestnut staves } 1st course.

One 16′ piece nailed from top and 4′ at bottom. Next stave 16′ from bottom and 4′ on top.

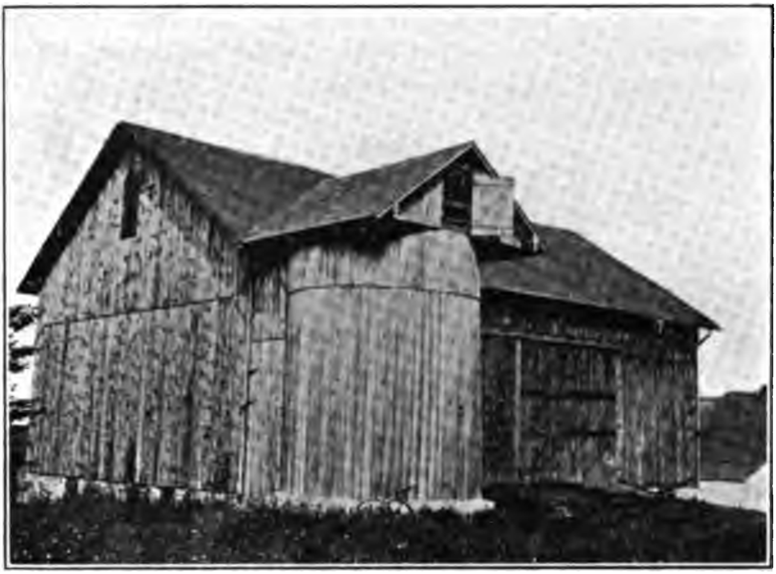
900 sq. ft. of tar paper.

50 P. 1″ x 6″ x 16′ chestnut staves } Inside
50 P. 1″ x 6″ x 4′ chestnut staves } 2d course.

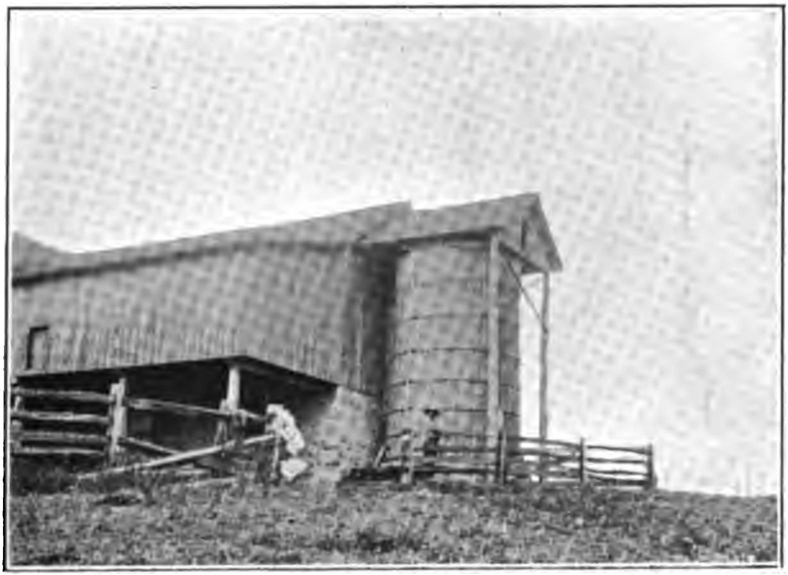
2,600 rough lathes.
20 P. 2″ x 4″ x 16′ rafters for roof.
200 ft. 1″ x 6″ sheathing.
2,000 shingles.
18 in. stone wall.
24 perch of stone or concrete.

Doors are concave built of staves lined with paper placed on two concave battens.

52. Silo of Mr. Albert Lintz, Phoenix, Baltimore Co. American Farm Co. (Corbett, Md.), stave silo, 14′ x 24′. Foundation same as sketch No. 2. Inside of silo was coated with gas tar which proved to be undesirable, as the silage adheres to the tar. This silo blew down twice which necessitated the bracing with the two large posts shown in the photograph (No. 52).

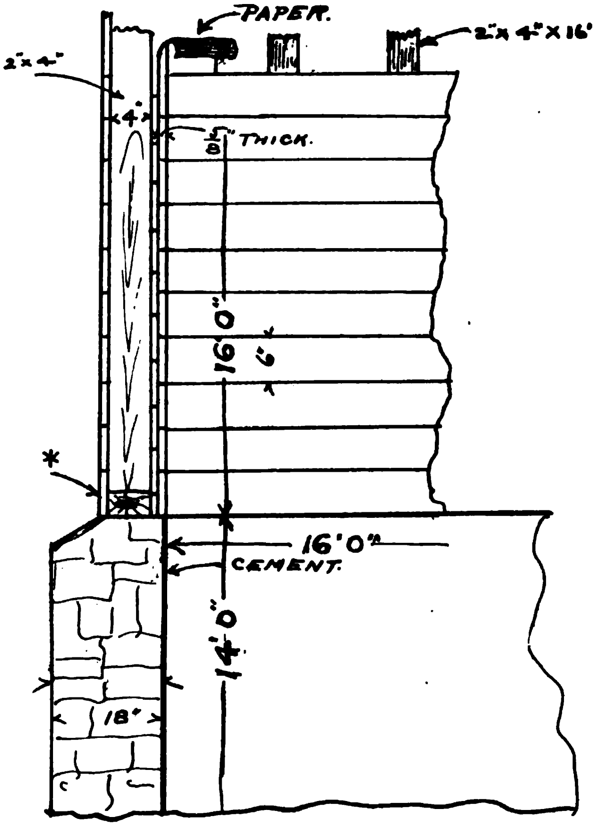


No. 51. Silo of G. E. Shelley, Phoenix, Baltimore Co.



No. 52. Silo of Albert Lentz, Phoenix, Baltimore Co.

53. Silo No. 1 of Mr. T. V. Richardson, Phoenix, Balto. Co. Modified Wisconsin style silo. Combination stone and frame, 16′ x 30′. Frame 16′ high. Stone portion, 14′ deep.



Showing Details of the Construction of Silo No. 53.

This silo is horizontally lined on inside and out with 6″ boards ⅝″ thick, this lining on inside is covered with tar paper and again horizontally lined with ⅞″ x 6″ boards. Oak is the best for this purpose.

45 Perch of stone required (18″).

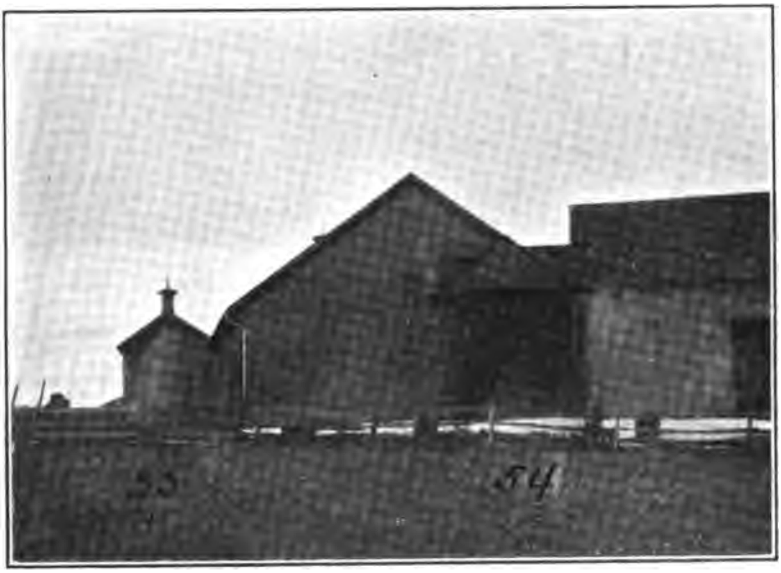
48 P. studding 2″ x 4″ x 16′, Va.

800 sq.ft. tar paper required.

2,500 sq. ft. ⅝″ x 3″ x 16′ boards.

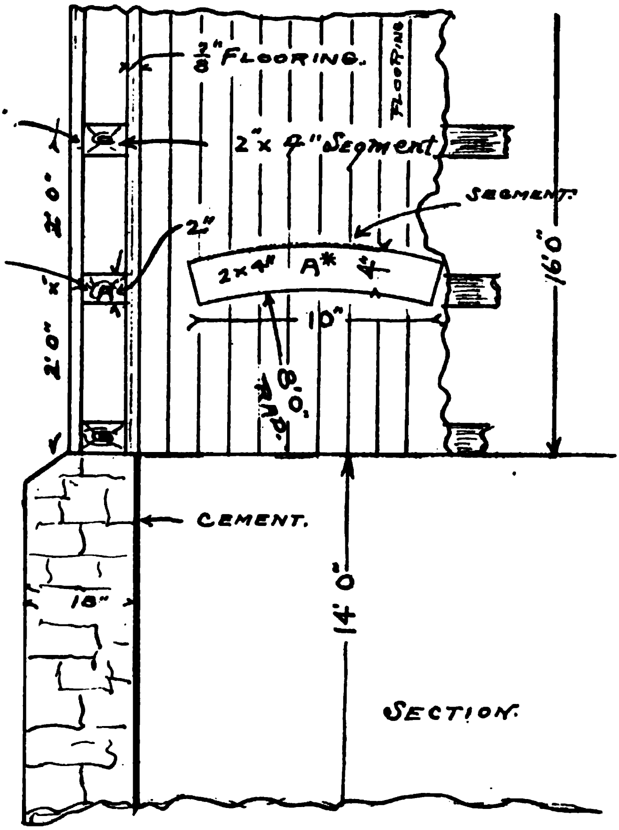
See sketch and photograph No. 53.

No. 53. Silo of T. V. Richardson, Phœnix, Baltimore Co.



Nos. 53 and 54. Silos of T. V. Richardson, Phœnix, Baltimore Co.

54. Silo No. 2 of Mr. T. V. Richardson. Combination frame and stone silo, size 16′ x 30′. The frame of this silo is built after the general suggestions of Mr. John Gould of Ohio, as given at the Farmers Institutes in Maryland and described in Hoards Dairyman, a copy of which is found on page 72 of this Bulletin.



Showing the Details of Construction of Silo No. 54.

The only difference between No. 1 and No. 2 is that the outside and inside are lined vertically instead of horizontally. The inside is lined with flooring (tongue and grooved), no paper.

45 Perch of stone.

48 P. Ver. studding 2″ x 4″ x 16′ Va.

10 P. Hor. studding 2″ x 6″ x 16′ Va. (segments).

To be nailed horizontally between studding two feet apart to receive inside and outside lining.

800 sq. ft. 1″ x 3″ x 16′ boards for outside.

800 sq. ft. ⅞″ x 2½″ x 16′ flooring (tongue and grooved) for inside.

See sketch and photograph No. 54.

55. Economy silo, 16′ x 35′ in course of construction on farm of Mr. C. E. King, Germantown, Montgomery Co.

56. Silo on farm of Charles R. Darby, Bucklodge, Montgomery Co. Wisconsin type of silo, 18′ x 25′, built after plans given in U. S. Department of Agriculture Farmers Bulletin No. 32.

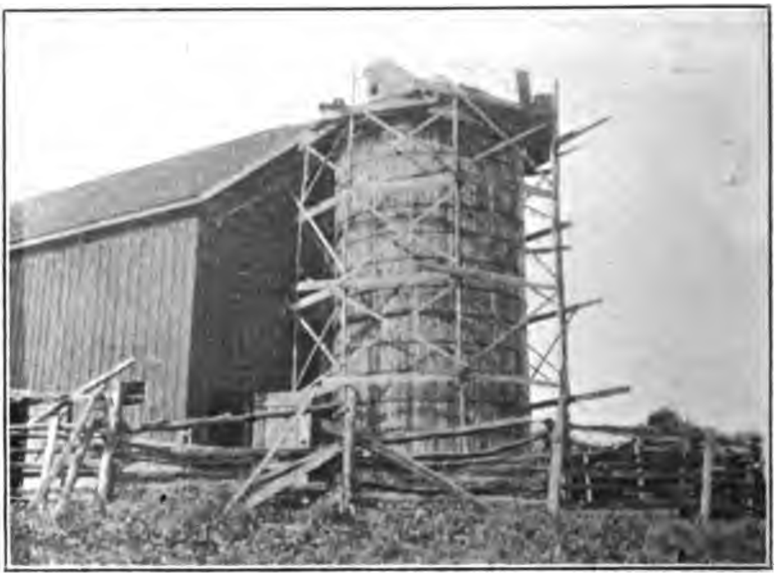
No. 55. Silo of C. E. King, Barnsville, Montgomery Co.

Built of studding horizontally lined on outside. Inside is lined to one-half of height vertically, and the top half is lined horizontally. This lining on the outside is double and has paper between. For construction see sketch and photograph No. 53.

57. Silo of Mr. Louis Pool, Germantown, Montgomery Co. Stave silo, 10′ x 20′, 3 years old. Mr. Pool places a series of braces across the diameter of his silo after the ensilage is removed and thus braces the silo which prevents it from blowing down; the braces are removed before filling.

58. Silo of Mr. J. L. Nicholson, Bucklodge, Montgomery Co. "Economy" silo, 14′ x 28′, one year old. For foundation see sketch No. 2. Tried one year without a roof, and scaffolding appearing in photograph was for the purpose of putting roof on and remains for the purpose of painting.

59. Silo of Mr. M. E. Wade, Bucklodge, Montgomery Co. Philadelphia stave silo, 16′ x 30′. Foundation same as sketch No. 2. Silo two years old and has given good satisfaction.



No. 58. Silo of J. L. Nicholson, Bucklodge, Montgomery Co.

60. Silos of Mr. David Reinhardt, Boyds, Montgomery Co. Two stave silos 16′ x 30′. For foundation construction see sketch No. 2. 175 head of cattle on place; barn holds 90 head,

There is a cement mixing trough, 3′ x 6½′ x 16′ in front of silos in the barn, one-half silage and one-half corn fodder are mixed with steam and fed warm.

There is a steam plant and engine used to run the separators. This plant is conveniently arranged and run in a business-like manner. See photograph No. 60.

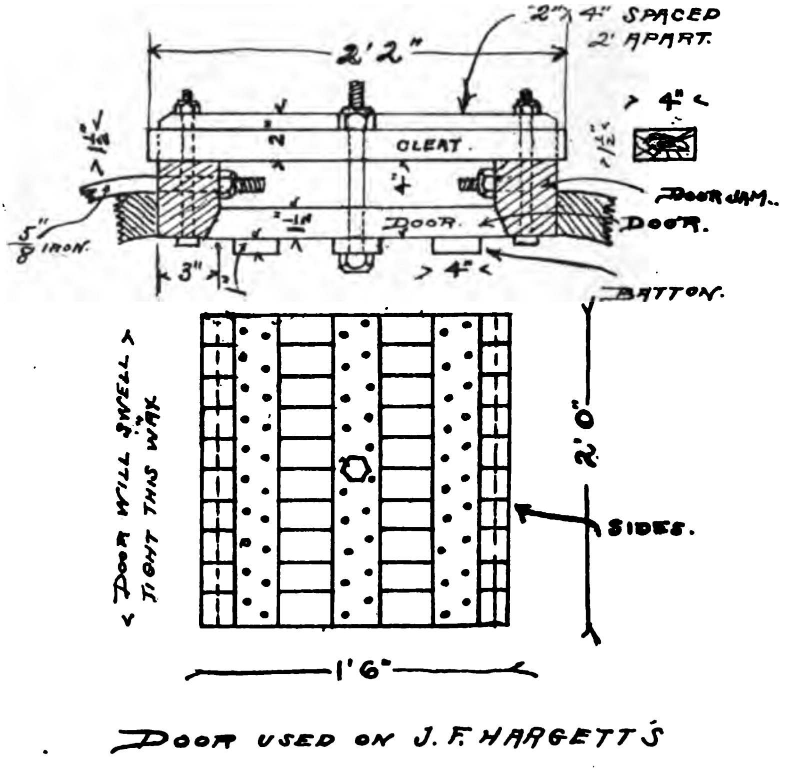
61. Silo of Mr. Eugene Macafee, Boyds, Montgomery Co. Philadelphia stave silo, 14′ x 30′. Foundation same as sketch No. 2. Shows

No. 60. Silos of David Reinhardt, Boyds, Montgomery Co.

No. 61. Silo of Eugene Macafee, Boyds, Montgomery Co.

blower in place for filling. This is a well-placed silo and when on a foundation two to three feet above ground gives better success than the combination silo.

62. Silo of Mr. John F. Hargett, Germantown, Montgomery Co. Home-made stave silo, 16′ x 30′. Foundation same as sketch No. 2 or No. 3. 8 perches of stone required for No. 2. 150 pieces 2″ x 4″ x 30′ chestnut, native sawed, lumber used in the rough. The staves are not tongue and grooved. Ten ¾″ round iron hoops are used.



Door used on J. F. Hargett's Silo No. 62.

There are a number of this style home-made silos in the vicintiy of New Windsor which are giving perfect satisfaction. See sketch and photograph No. 62.

63. Photograph shows silo 16′ x 30′ of Mr. G. T. Shafer, Germantown, with gable roof which affords ventilation. Note wire guy lines to prevent silo from blowing down.

No. 62. Silo of John F. Hargett, Germantown, Montgomery Co.

No. 63. Silo of F. G. Shafer, Germantown, Montgomery Co.

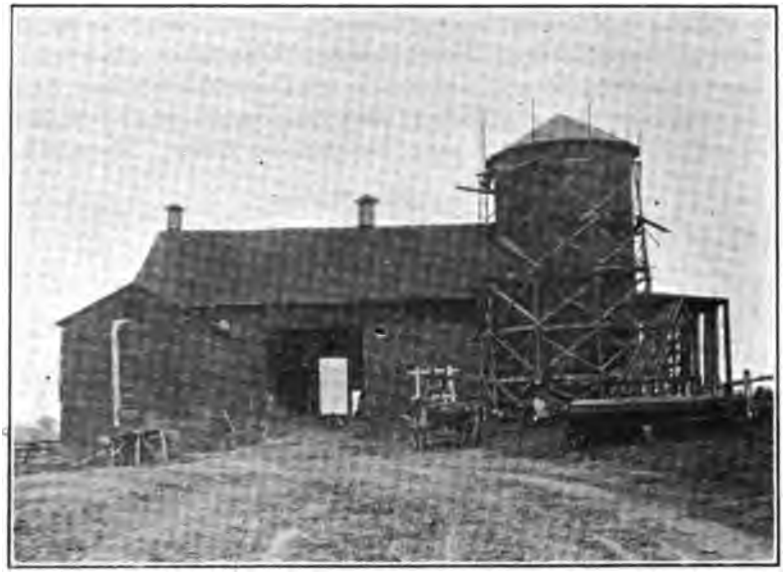
64. Silo on Westward farm of J. B. Diamond & Sons, Gaithersburg, Montgomery Co. Harder, Cobelskill, N. Y., stave silo, 22′ x 40′. Cost about $500. Required 3 men four days to erect. Photograph shows scaffolding remaining for use of painters. Foundation 3′ below and 1′ above ground. The barn shown in the photograph is 34′ x 168′ and houses 125 cows.

65. Silo on East farm of J. B. Diamond & Sons, Gaithersburg. Harder stave silo, 18′ x 36′. Foundation 12″ above ground, stone. The scaffold is still in place, which was used to reconstruct the silo, it having been blown down.

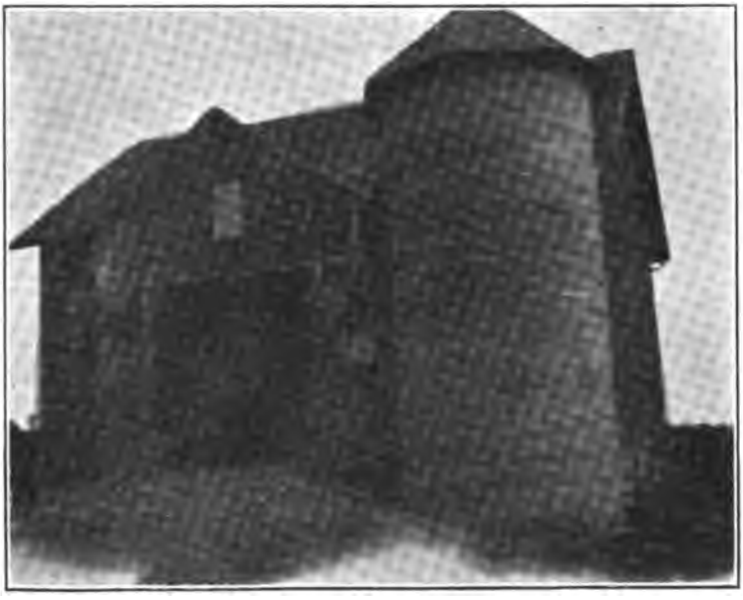
No. 64. Silo of J. B. Diamond & Sons, Gaithersburg, Montgomery Co.

The frame work of an abandoned rectangular silo stands to the right of the photograph at the end of the barn. To the left is a rectangular silo still in use, the blower is in place for filling. This silo is 15′ x 25′ x 25′ and had square corners, but was improved by reconstructing into an octagon shape which keeps silage fairly well. This has a stone foundation and the silo is all above ground.

66. Silo of Mr. Robert H. Miller, Spencerville, Montgomery Co. Home made, 14′ x 32′. Built after a modification of the Wisconsin style from lumber sawed on the place. Silo 4 years old. Foundation

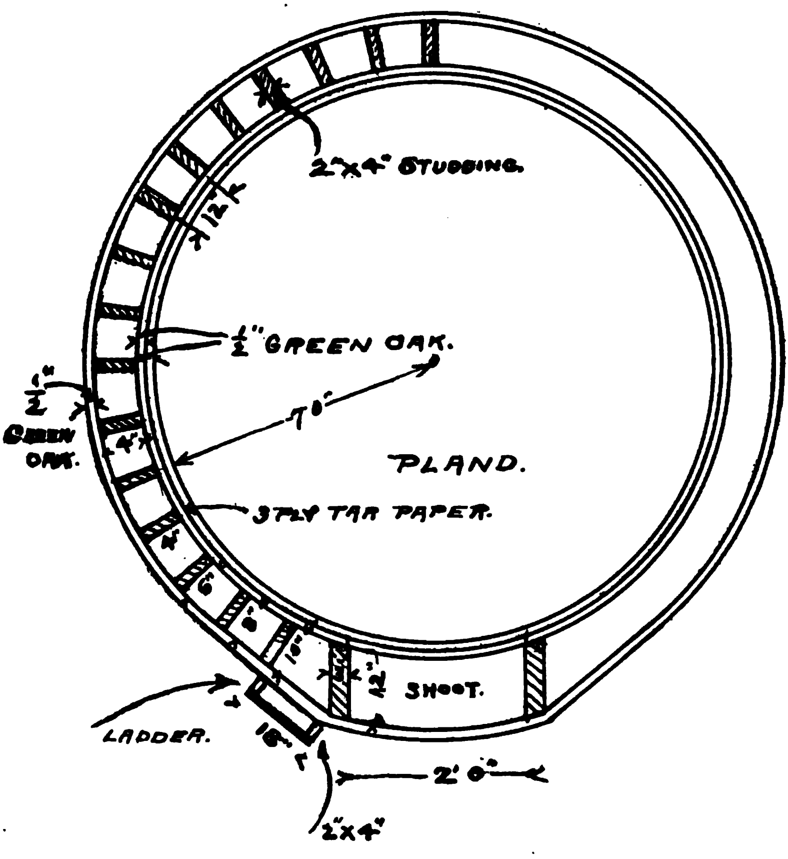


No. 65. Silos of J. B. Diamond & Sons, Gaithersburg, Montgomery Co.



No. 66. Silo of Robert H. Miller, Spencerville, Montgomery Co.

same as No. 1. Mr. Miller does not believe in cemented bottoms as he thinks they prevent the acid from escaping through the ground. This silo has a shingled roof. ½″ x 6″ boards are placed horizontally on outside of vertically placed studding, with two courses of ½″ x 6″ boards nailed horizontally, with tar paper between, on inside. Three-ply tar paper was used, but two ply is considered ample. 4 doors 2′ 6″ x 3″ feet high. The horizontal covering on the outside continues around between the four doors, thus forming hoops which retain a symmetrical form and adds strength to the silo. Eight penny cut nails were used in construction. Silo is painted red. Silage is stamped around the edges when filling and a saucer shape is maintained until filled. Bottom



Cross-section, Showing Construction of Silo No. 66.

board on outside is left off to allow air to circulate, and afford a place to remove the silage which has blown between studding. Note the increased width of studs at each side of doors which forms the chute for throwing the silage from the silo to the stable. See sketch and photograph No. 66.

Material used in constructing silo:

12 Perch stone.
Studding required:
68 P. 2" x 4" x 16' Virginia pine.
4 P. 2" x 6" x 16' " "
4 P. 2" x 8" x 16' " "
4 P. 2" x 10" x 16' " "
4 P. 3" x 12" x 16' " "

1 P. 1" x 12" x 16' for splicing studding.
1 P. 1" x 10" x 16' " " "
1 P. 1" x 8" x 16' " " "
1 P. 1" x 6" x 16' " " "
9 P. 1" x 4" x 16' " " "
600 P. ½" x 6" x 16' green oak.
1500 sq. ft. 3-ply tar paper.

Cut splices 4 feet long and nail one piece on each side.

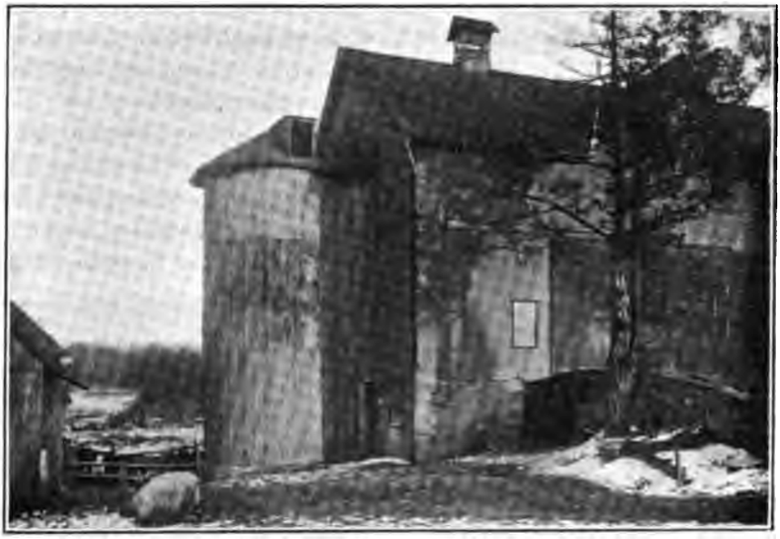
67. Silo of Dr. Augustus Stabler, Brighton, Montgomery Co. Home-made, same style as No. 66. Size 16' x 35'. Four doors 2' x 2'. Ladder straddles door. Silo 7 years old. See notes on No. 66. See photograph No. 67 which shows method of construction at the top where outside sheathing has not been put on.

68. Silos of Mr. P. T. Stabler, Sandy Spring, Montgomery Co. No. 1, stave silo, 16' x 32'. Three years old. Hoops are made of three pieces of oak ½" x 4" at top, ½" x 6" at bottom. Constructed according to design No. 51, G. E. Shelly. These hoops are put in a pile on the foundation and scantlings are put on the outside the desired height of the silo. The hoops are hoisted one at a time and nailed to the scantlings, which are 2" x 4" placed 2 feet apart. When these hoops are placed 2 feet apart, nail the ⅞" Georgia flooring vertically to the hoops on the inside. After the inside has been well nailed the scantlings can be removed, and the outside vertically covered with 1" x 6" chestnut, or other material which will prevent the weather from decaying the studding and lining. Use two boards 16 feet long, vertically; next place

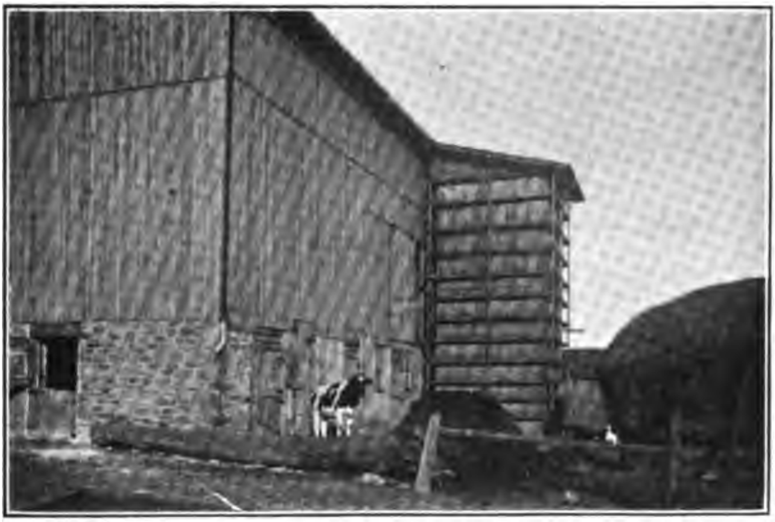
an 8 foot, 16 foot, and 8 foot, then use two 16 feet boards, and so on until the inside is finished, then proceed to do the same on outside. There are 6 doors 2 feet square. Cost including work and material, $120. See photograph No. 68. No. 2, rectangular silo, 12′ x 12′ x 38′. Frame part 28 feet high and stone portion 10 feet deep. This is an older silo than No. 1. This silo is built like that shown in Fig. No. 2, sketch No. 20, lined on inside with ⅞″ yellow pine flooring. There is no vertical covering on outside of horizontal frame, it being exposed to the weather. The frame work, or square hoops, are made of 2″ x 10″, the lining being nailed to the 2-inch side. The corners of this silo are round, a 2 feet radius being used. The 10′ of masonry was placed under this silo after it was built to increase its capacity.

No. 67. Silo of Dr. Augustus Stabler, Brighton, Montgomery Co.

This silo was first lined on inside vertically with 1″ x 6″ rough boards. Tar paper was then applied, and 1″ x 6″ rough boards nailed vertically, 3 inches in advance, making 3-inch laps. On this was nailed the ⅞″ yellow pine flooring, previously mentioned, thus making three layers of boards with one layer of tar paper between. This style silo keeps silage well, silage having remained in this silo two years and was in good condition when fed. See photograph No. 68a.



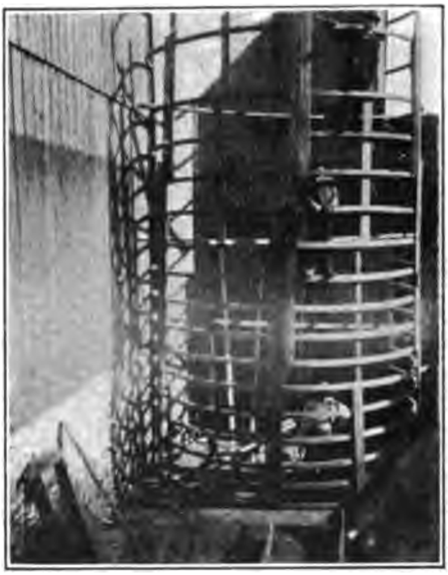
No. 68. Silo of P. T. Stabler, Ashton, Montgomery Co.



No. 68a. Silo of P. T. Stabler, Ashton, Montgomery Co.

69. Silo on farm of Mr. Wm. L. Amoss, Benson, Harford Co. Home-made, wood hoop or Gould type, with vertical lining of tongue and grooved flooring. Size 15′ x 30′. Foundation, cement, for construction see No. 3. Mr. Amoss describes the construction as follows:

The extra heavy Georgia pine flooring is nailed to 18 hoops made as previously mentioned in design No. 51, or they can be made on a form of two pieces of 4″ x 4″ x 14′8″ oak, half lapped in center, this cross is placed on a level piece of ground and boards 1″ x 6″ placed edge up are used as intermediates, the ends of which touch the desired diameter. Stakes are driven on the sides of the boards to keep them in place, about 3 boards between each quarter, thus making a wheel without a fellow. The green white oak strips are bent around this form until four layers have been nailed together, thus making a hoop 2″ x 3″ x 15′ outside diameter. For construction see No. 68. At the base these hoops are spaced 1′0″; in the middle 1′3″; at the top 3′0″. The scaffolding which is used to raise the hoops in place must be well secured and braced.



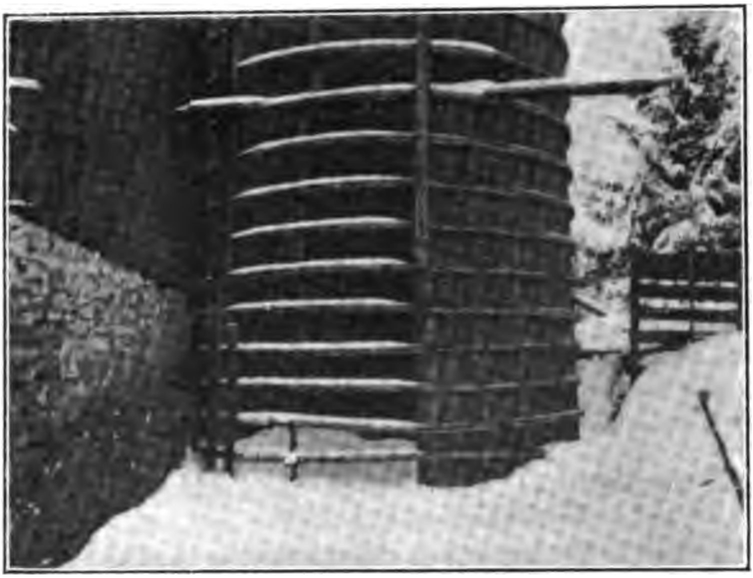
No. 69. Showing Hoops and Method of Framing and Constructing Silo 69a.

The opening for the doors is 8 feet from the top and 4 feet from the bottom.

Be sure and break the joints on the hoops and only one joint at a place.

The doors and frame work were furnished by the Economy Co., Frederick, Maryland.

All the work was done by farm labor directed by the farm manager. The silo was constructed in the summer and winter, working at convenient times. Photograph No. 69 was taken in the summer and photograph No. 69a was taken in the winter. No roof has been placed upon it and none is thought necessary.



No. 69a. Silo on farm of Wm. L. Amoss, Benson, Md.

This silo was filled last season and kept silage satisfactorily. No cracks appear in it through the summer months and it is as rigid as when built. Should another silo be built it would be a duplicate of the first as it has cost much less than the commercial silos, has not required any attention on account of shrinkage or expansion of iron hoops. See photographs No. 69 and 69a.

70. Silos at the Experiment Station. There are at the Experiment Station at present 3 silos. One built of Georgia pine (not tongue and grooved) lumber purchased in the local lumber yard, and two Kalama-

zoo Redwood silos, tongue and grooved. All of these silos are 12′ x 30′ and have iron hoops. It is contemplated building a reinforced cement silo.

Ten other farms were visited and notes were taken on the silos on them: but as they showed nothing different from those already described they have not been included.

A NEW ROUND SILO AS DESCRIBED BY JOHN GOULD IN HOARDS DAIRYMAN.

This plan does away with thick staves and combines in their place the single inch flooring of Georgia pine that has come to be recognized as the best lumber with which to line up a silo, because of its non-shrinkable character.

The foundation of this new silo is in its wooden hoops, made out of half-inch by six-inch-wide elm lumber sprung around a form, and built up with well lapped joints, using a trifle longer nail each time around, until this hoop has a thickness, for the three bottom hoops, of five layers. This calls for 60 ft. of lumber for each hoop, as the remaining five top hoops only need to have four "lifts" each, less than 476 feet of lumber will be needed, and 20 lbs. of 6 and 8d. nails. The hoops are easily and quickly made, and a builder estimates that their cost should not exceed $1.25 each, which would be somewhat less than the $36.00 estimated for iron hoops and lugs. A three cornered frame is erected at the exact outside diameter of the silo, and the hoops placed into position and fastened.

The lining of the silo is then put on, and should be of one inch by three inch wide, matched Georgia pine flooring, and put on and nailed to the hoops the same as flooring. When the lining is on within twenty inches of the starting, stop and cut in 2 x 4 studding up and down between the hoops on each side of the door, for door stays and jambs, and take the remaining flooring and make the doors; cutting them into "joints" on the outside of the hoop.

Then well paint the silo and hoops on the outside, and if the silo is to be on the outside of the barn, it can be cheaply covered by stripping up and down on the outside with tarred paper, and covering with cheap up and down siding, which in reality gives two air spaces, and will be a reasonable protection against the frost.

This silo is one of great rigidity. Its lining does not shrink out of place any more than in a square walled silo, and its hoops are exactly so long and so short every day in the year. The material required would be about 400 feet of elm, or springy ash lumber; 1300 feet Georgia pine flooring, a keg of 8d nails. A builder estimates $20.00 worth of labor for constructing.

The roof and foundation is the same as any ready made silo, and as the man may select, and the outside covering would be governed by the owner's wishes; or it might go without siding, the same as any tub silo. If protected from the weather, the "life" of wooden hoops would be for years, and if at any time the inside lining of the silo became "dozy," it could be stripped up with tarred paper, and a thin flooring put on over, which would make it a serviceable silo again for several years at small cost.

CONCRETE SILOS.

When all things are considered the reinforced concrete silo is probably the best and most economical one that can be built, They have not been adopted in this state but are much in favor in many sections in the Western States as is evidenced by articles and advertisements in papers. Concrete silos should be round and of the same general dimensions as has been found best in the construction of wood silos. They may be built of hollow curved blocks made especially for this purpose, or solid reinforced walls may be used. The latter method of construction would probably be the cheaper and more durable and satisfactory.

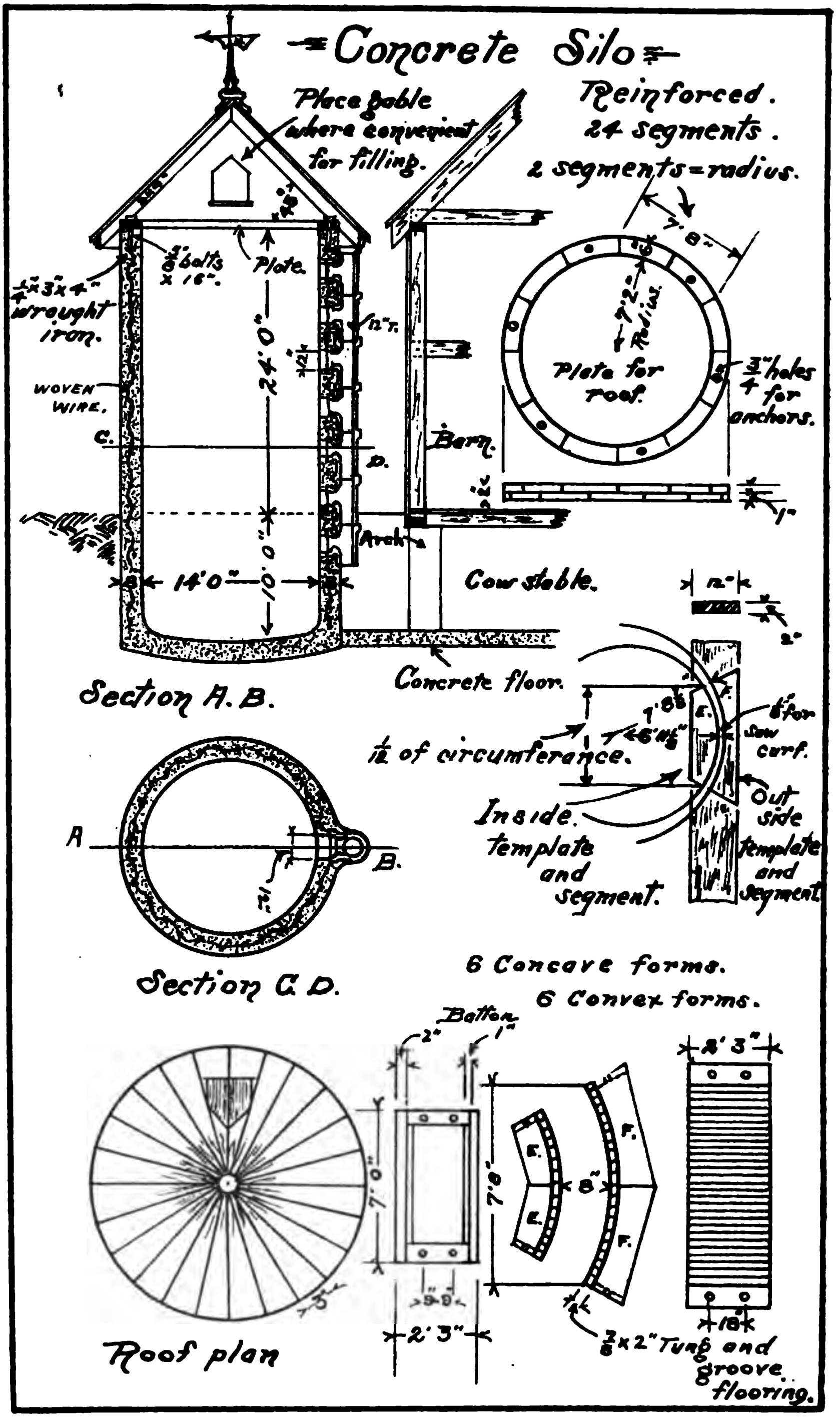
Figures 70 and 71 give drawings showing the construction of concrete silos and method of making forms.

REINFORCED CONCRETE SILO.

The first step in the construction of this kind of a silo is the foundation or footings. This part should be made about the same as for wood silos, except that it might be well to have it a little deeper and stronger so as to carry a greater weight.

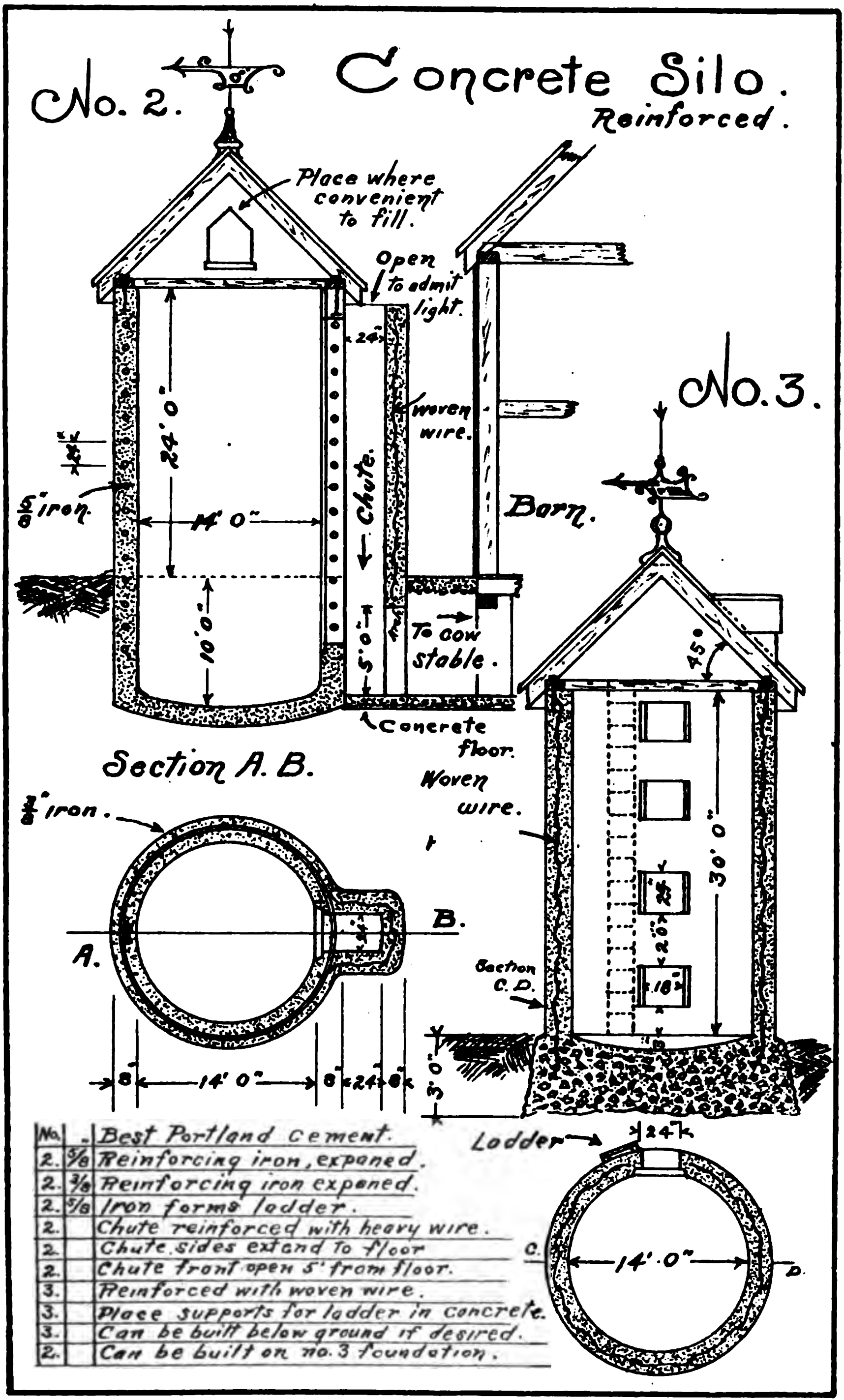
THE FORM.

In making a solid reinforced concrete wall it is necessary to have a form. The form may be constructed in various ways, but the best forms are those built in sections and bolted together as they are more convenient to move. A properly built form should give a smooth surface. The ribs, or templet, of the form can be made on the same general plan as those for a well curbing, and they may be cut into sections afterward, or built in sections as most convenient. It would require



H. L. CAVER RELAY MO.

No. 70. Showing Construction of Concrete Silo.



No.	.	Best Portland cement.
2.	5/8	Reinforcing iron, expaned.
2.	3/8	Reinforcing iron expaned.
2.	5/8	Iron forms ladder.
2.		Chute reinforced with heavy wire.
2.		Chute sides extend to floor
2.		Chute front open 5' from floor.
3.		Reinforced with woven wire.
3.		Place supports for ladder in concrete.
3.		Can be built below ground if desired.
2.		Can be built on no. 3 foundation.

H. L. CRISP RELAY MD

No. 71. Showing Section of Concrete Silos.

two set of ribs, or templets, for the forms. One set should be concave and have the inside of the rib of a circumference equal to the outside of the silo. The other set should be convex, have the outside of the rib of a circumference equal to the inside of the silo. The ribs can be made of any kind of material but they should be at least two inches thick so as to be strong and give a ridged form. Flooring, two inches wide is good material to nail to these ribs to complete the form.

Fig. 70 shows drawings of a concrete silo and the method of constructing a convex and concave templet one-twelfth the diameter of the silo.

The form should be only 3 feet in height. The form should be moved up two feet each day as that will give as great a depth of concrete as should be filled at one time and this will allow twelve inches of the form to rest against the concrete previously placed. The forms for Nos. 2 and 3, Fig. 71, should be built same as in Fig. 70 making allowance for the changes in design. For No. 2 the sections should meet in the center of the chute on the outside so that it can be readily removed. In No. 3, Fig. 71, a frame should be provided for making the cavity for the doors.

The forms should always be carefully and firmly set so as to make the silo plumb and true, and it is especially desirable to have a smooth surface on the inside. The ribs of the forms may be made wide enough to serve as scaffolding for the workmen.

These forms will last for a number of silos, so it would be well for the farmers of a neighborhood to coöperate in making them so that all could avail of their use and thus reduce the expense.

REINFORCING.

There are many different kinds of steel on the market for use in reinforcing concrete. Old iron can be utilized for this work. Extra heavy woven wire fencing has proven very economical and satisfactory to those who have constructed a number of concrete silos. The two ends of the wires should be securely fastened together so as to give a complete frame work. In No. 2, Fig. 71, ⅝ in. square twisted reinforcing iron placed 24 inches apart is designated. These irons also form the ladder. The vertical reinforcing is of ⅜″ twisted square iron cut in 4 ft. lengths and placed 12 inches apart.

THICKNESS OF WALLS.

The walls of the silo should be from 4 to 8 inches thick, depending upon the size of the structure. An experienced builder of concrete silos in Minnesota recommends a 4-inch wall for a silo 16 feet in diameter and 24 feet high, and in practice has found that thickness sufficient.

MATERIAL.

In constructing a concrete silo nothing but first-class Portland cement, sand and gravel, or crushed stone, should be used.

The Portland cement should be No. 1 and fresh.

Sand must be clean, sharp, and free from loam and foreign matter.

Crushed stone or gravel must be clean, hard material and not larger than will pass through a 2-inch mesh, and should contain nothing smaller than ¼-inch.

The concrete should be mixed in the following proportion:

One part Portland cement.
Two parts sand.
Four parts gravel or stone.

Mix sand and cement dry, turning it four or five times to insure a thorough mixture. Then add enough water to make a thin mortar, the consistency of brick mortar or plaster. Then add the gravel or stone, mix four or five times, then dump into the forms at once and thoroughly work and tamp with rod or pole so that the concrete sets firmly around the reinforcing and against the forms. Concrete should be used within thirty minutes of the time it is mixed.

DOORS AND CHUTE.

Doors and chute in the silo may be made after any of the plans suggested by the drawings in Figs. 70 and 71. In Fig. 70 the chute is made by using twelve-inch terra cotta pipe tiles. The center inlet being cemented in the silo when constructed. One of the concave forms will have to be recessed enough to allow the tee to be placed in position. A form of wood will be needed to suit the diameter of the tee and long enough to reach the inside form of the silo. This form will be placed in position in the socket end of the tee before the inside form is placed. This will form a delivery cavity to the opening of the tee. Fig. 71 shows a concrete chute with a continuous door to be closed by white pine sectional doors, and also a silo with doors 3 feet apart.

LADDERS.

In Fig. 71 the reinforcing iron forms the ladder to the silo with the continuous door, and iron staples should be inserted in the concrete to form the ladder in the silo with the intermittent doors. The silo with the terra cotta chute shown in Fig. 70 should be supplied with an iron ladder on the outside to the door in the roof and sockets should be placed in the inside wall for screwing in a hand hold ladder. These could be placed in position as the silage is removed, and taken out as the silo is filled.

The estimates in the papers place the cost of a reinforced concrete silo, 16 feet in diameter and 24 feet high, at $150.00 to $200.00.

This kind of silo will not rot and should be stronger at the end of five or six years than when built.

A very good concrete silo is described on page 78 in the book issued by the Atlas Portland Cement Company, 30 Broad St., New York, N. Y. entitled "Concrete Construction about the Home and on the Farm." This book is also valuable for the general information given on the use of cement. Farmers Bulletin No. 235, published by the U. S. Department of Agriculture also gives valuable general information on the use of cement.

LITERATURE.

On Silos, U. S. Department of Agriculture, Farmers Bulletins Nos. 32, 103, 190 and 292.

On Silage, U. S. Department of Agriculture, Farmers Bulletins Nos. 32, 56, 103, 124, 133, 165, 222, 267 and 309.

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NURSERIES AND NURSERY INSPECTION

BY T. B. SYMONS, J. B. S. NORTON AND C. P. CLOSE.

INTRODUCTION.

The United States Census for 1900 states that there are 4609 acres devoted to the nursery and plant growing business in Maryland with about one and a half millions of dollars capital invested in the business. The annual sales of these nurseries amounts to about $480,000.

The ability to control San José scale and other insects and also most plant diseases by spraying has restored confidence as to the future profitableness of commercial orcharding; the increased interest in beautifying and developing the suburban homes during the past years as a result of the very general prosperity of the country and the extension of electric railroads into the rural districts; the improvement and extension of the public parks around the towns and cities; and the establishment of school gardens and encouragement of home gardening among the children; all have contributed together with improved shipping facilities to make a largely increased demand for all classes of nursery plants, both the commercially useful and the ornamental.

Maryland nurserymen have met this increased demand, and as a result this industry has grown rapidly in area and some in numbers during the past eight years and at present has bright prospects for still further development in the future. Today Maryland has some nurseries which rank amongst the largest in the United States.

The system of nursery and orchard inspection inaugurated in Maryland in 1898 has done much toward developing the nursery business and inspiring confidence in their patrons. With an idea of still furthering this mutual relationship and interest this Bulletin has been prepared so as to place in the hands of all interested parties detailed information as to general methods of growing nursery stock and controlling insects and plant diseases, and the methods of inspection and certification which are followed not only in Maryland but in other states, together with a summary of the laws which govern inter-state shipments.

GENERAL HORTICULTURAL POSSIBILITIES.

There is such a wide range of soil, slopes, elevations, influence by proximity to large bodies of water, shipping facilities by rail and water, and general conditions, that the horticultural possibilities of this state are surpassed by very few of the states in the Union. The Eastern Shore and Southern Maryland are especially adapted to the growing of summer apples, peaches, pears, plums, small fruits and nuts. The north central portion produces these crops abundantly also, and is especially adapted to the production of winter apples. The western counties, being more or less mountainous and rugged, with cool bracing summer weather and extremely low winter temperature, are especially suited to the growing of the hardiest winter apples and pears.

It would be difficult to find well drained soil in Maryland that could not be made profitable in producing some kind of fruit.

SELECTION AND CARE OF A NURSERY.

In selecting a location for the nursery there are several vital points to be considered, such as convenient shipping facilities, supply of labor, moderate winter climate, freedom from disease and insect pests, ease of securing packing material, price of land per acre and the kind of soil. The more favorable the location with respect to these points the more profitable and satisfactory will be the results.

During recent years the uncertainty and unreliability of laborers have been the greatest annoyance in many parts of the state. The problem, however, is more or less local and must be solved locally. A mild winter climate is desirable for doing a great deal of work in preparation for spring shipments before the rush of spring work is on. If nursery stock is to be shipped to the South it may be got off and out of the way early, while stock for northern shipment can usually be held dormant until it may be started north.

Packing material is a considerable item in nursery operations, and a great saving is made by locating where moss, old straw, strawy horse manure, marsh hay or fine excelsior and cheap lumber, may be readily obtained.

SOIL AND CULTURE METHODS.

The ideal soil for nursery work is rich, sandy loam with clay subsoil. This can be worked early in spring or after a rain without danger of puddling and baking. It makes a most favorable home for the roots and responds quickly to the use of fertilizer.

If a rather thin sand must be used, it may be built up by the liberal use of stable manure, crimson clover, cowpeas and commercial fertilizers. It must be remembered that a crop of nursery stock is especially exhausting to the soil and at least as much fertility should be added as the crop of trees removes.

Heavy soils like clay loams may be successfully used, but a great deal more care is necessary to successfully handle them. If plowed when too wet they become puddled and baked, and if plowed when too dry they become lumpy. The nurseryman must work out this problem on his own land.

Before the seeds, root grafts or seedlings are planted, the ground should be most thoroughly prepared, putting it in the best possible condition. This thorough preparation saves work later and produces better growth of trees. Clean, shallow and frequent cultivation and destruction of all weeds, are essential. About the first of August the last cultivation should occur and then crimson clover seed, 15 or 20 pounds per acre, should be sown for a cover crop during the winter providing this system can be made practicable. Even though the trees are dug in the fall the crimson clover will not be used in vain, because some will be spared to protect the ground and add fertility to it. There will be some difficulty in cultivating out the clover plants between the rows in the spring, but the fertilizing value of the clover will well repay the extra labor necessary. Cultivation and clover may well be made the watch words in handling the soil.

ISOLATION FROM SCALE AND YELLOWS.

Aside from the primary points in the location of a nursery, viz: the quality of soil and transportation facilities, the nurseryman should consider the prevalence of the San José scale and peach yellows in any particular district that he may have selected. When the scale has become well established in a nursery it requires heroic action and treatment, which entails severe losses in preventing its spread. The officers of the State Horticulture Department will do all in their power to cause effective treatment of infested orchards in the vicinity of a nursery, for in no other instance will negligence on the part of growers cause so much trouble and financial loss. Furthermore, even if adjoining orchard trees are effectively treated, their existence may be called a nuisance to the nursery, for it apparently is impossible to eradicate the scale on such trees, and accordingly they serve as a continual menace to the nurseryman. While seldom has an authenticated case of yellows been detected in the nurseries of Maryland, nevertheless, it is of vast importance that nurseries be isolated as much as possible from infected trees, likewise with this disease the utmost efforts of the department are employed to cause to be destroyed all infected trees in the neighborhood of nurseries. It is therefore apparent that the presence or absence of this insect and disease in any locality should be considered as of fundamental importance in determining the location of a nursery.

IMPORTANCE OF SELECTING BUDS AND CIONS.

The selection of buds and cions is the most important item connected with the growing of nursery stock. What does it matter how large and strong, healthy and symmetrical a tree is if it is a poor strain of the variety. That there are excellent, good and poor strains of any established variety of fruit, it requires only fairly good eyesight to prove while passing through an orchard. Some trees are heavy and quite regular bearers of fine, large, highly colored fruit, while others are indifferent bearers of small light colored fruit. Since in nature the tendency is for the progeny to resemble its parent, it is only good common sense to follow the practice of taking buds and cions from trees known to be superior types of the variety. Thus a choice strain of the variety may be secured. Such a strain is often called "pedigree" stock, and it may or may not merit the name.

Fruit growers should understand the advantage of procuring trees thus propagated, and also understand that it entails added expense to the nurseryman to produce such trees and he must necessarily receive a higher price for them than for ordinary trees. The fruit grower should willingly pay the extra price, knowing that it is the best investment he can possibly make in nursery stock.

Since it is entirely impossible for the nurseryman to obtain enough buds and cions for his purpose from desirable bearing trees every year, the practice of using buds and cions from nursery trees of selected strains must necessarily be followed for a year or two at a time, but this should be done as little as possible and bearing trees should be depended on for budding and grafting wood every second year.

The old practice of propagating year after year from nursery trees is unsatisfactory and unreliable and should be condemned. Nurserymen often continue propagating varieties for years in this way without ever seeing the fruit and do not know whether or not they have the variety true to name. As soon as the fruit growers demand better bred stock and are willing to pay for it, the old practice is doomed and the sooner this occurs the better it will be for the industry of fruit growing.

The best method of all for the fruit grower if he depends upon purchasing his trees, is for him to select the budding and grafting wood, send it to the nurseryman, and employ the nurseryman to propagate the trees. Thus the fruit grower does the best possible thing for himself and for the fruit growing industry.

GROWING LOW HEADED TREES.

Until within the past few years everybody who grew fruit trees wanted great, tall, "long-legged" ones, so that a team might be driven beneath the lowest limbs. Most of the Eastern fruit growers still live in the past in this respect. In the Far West the warm sun of mild winter days caused sun scald on the tall tree trunks and the fruit growers learned that a low headed tree shaded the short trunk enough to protect it and the practice of growing low headed trees followed. The East is slow to adopt this improved method, but it is gaining ground.

Compared with high headed trees the low headed ones have the advantage of being easier to prune, spray, graft or bud, gather fruit from, and are as easy to cultivate. Thus a saving in expense in caring for the trees is made. Falling fruit is not injured as it is when falling from a high headed tree.

Nurserymen ought to take the lead in advocating low headed trees, and those who propagate, advertise and push the sale of such trees will reap the reward. A nursery tree should have only those limbs within one foot of the ground removed instead of being mutilated and "beanpoled" four feet from the ground. If the tree remains in the nursery the second year the "leader" should be topped at about two and one-half feet and the side branches be cut back to perhaps four inches; this is the proper way to form foundation branches for apple, pear and plum trees. With peach trees which are always dug when one year old or less, the side branches should never be taken off in the nursery. They should be left for the fruit grower to develop into low headed trees.

CONTROL OF INJURIOUS INSECTS IN A NURSERY.

Accompanying the greatly increased plantings of nursery stock and the introduction into the East of the notorious San José scale, insect control in the nursery has assumed great importance. Negligence on the part of nurserymen in this important aspect of their business will shortly and easily bring about failure. Even with the aid of state inspection of nurseries and many investigations for the control of those pests most harmful to them, the nurserymen have suffered great losses in their efforts to produce clean, healthy stock. The importance of controlling insects and diseases has led many nurserymen to employ competent men whose duty it is to superintend this phase of the work. This procedure can not be too emphatically urged in all large nurseries. Not alone should there be a man whose duty it is to watch the nursery throughout the growing season for the first appearance of insect attack, but he should be assisted by a corps of men who have had experience in spraying and other treatments employed for insect control, whom he can place on any outbreak that should occur. The size of the force will be dependent upon the size of nursery. Nurseries will find the money expended for labor in this direction, intelligently directed, very profitable. Too much stress cannot be placed upon the importance of having such work properly directed, for even in applying insecticides much injury can be done if the proper materials and strengths are not employed for each particular insect attack.

Too much attention cannot be paid to general nursery management in the control or prevention of insect attack. Clean culture methods should be employed. The practice of carrying over the odds and ends of the previous year's stock heeled in the yards or elsewhere, cannot be too strongly condemned. The constant exchange of stock among nurserymen to enable them to fill orders should be conducted with much care. All such stock coming into a nursery should be carefully examined to prevent as far as possible new pests being introduced and established.

Nurserymen should also be careful to see that all fruit or other trees likely to harbor insects in the immediate neighborhood of the nursery are destroyed. When such trees become infested with nursery pests they serve as a constant source of infestation to the growing stock. The nursery and its surroundings should be as free as possible from fruit trees, wild cherry, sumach, hawthorn, osage orange and other hedges.

A detailed description of all nursery pests would be superfluous in this connection, inasmuch as they have appeared in previous Bulletins of this Station. It is only desired to cite briefly here the most common pests with the latest methods of combating them.

SAN JOSÉ SCALE.

The introduction of this pest in the East and its spread into many nurseries has been a source of severe loss to those nurserymen. Many Maryland nurserymen have shared these losses in the destruction of stock infested by this insect.

The enormous number of food plants upon which this insect has been found makes it one of the most difficult pests to eradicate or control in the nursery.

Scale has been found on the following plants in the nursery:—peach, plum, apple, pear, apricot, cherry, quince, almond, hawthorn, osage orange, currant, gooseberry, raspberry, strawberry, grape, rose, spirea, flowering quince, flowering currant, prunus pissardii, cotoneaster, mountain ash, english walnut, black walnut, pecan, persimmon, elm, linden, willows, poplars, cottonwood, maple, catalpa, sumach, lilac and privet.

The control of this pest in the nursery is of necessity quite different from means employed in the orchard. A nurseryman is not supposed to sell a tree that is infested with scale, therefore, when the San José scale is present in the nursery, prompt measures should be employed to prevent its spread. The nursery stock should be gone over carefully row by row and the infested trees dug up at once and destroyed. This work should commence in spring and continue during the summer, as one infested tree in a block in the spring will serve to infest thousands of trees in that and adjoining blocks if allowed to remain throughout the summer. Therefore what is known in nursery parlance as "chasing" scale in the nursery rows by keen eyes is certainly valuable work. After going over an infested block in this manner the trunks of the trees should be then treated with whale oil soap, using two pounds to the gallon of water. This will not only serve to kill any scale on trees that escaped the "chaser's" eye, but it otherwise is a good treatment for the trees as it cleans the bark, thereby improving the general appearance of the stock.

The practise of fumigating all seedling stock, buds, grafts or cuttings used for propagation purposes either from outside sources or from one's own nursery with hydrocyanic acid gas can not be too strongly recommended. Recent experiments have demonstrated that this gas will not injure peach buds during the budding season when properly used even at the normal strength recommended for fumigating nursery trees.

Spraying for this pest regularly during the dormant season should be practiced by nurserymen even if the scale has not been found in the nursery. It is a good preventative and also serves to add vigor to the trees. The lime-sulfur wash is no doubt the most satisfactory remedy for spraying young stock. A discussion of the various washes on the market for scale has appeared in recent bulletins from this Station, and these results will be supplemented from time to time in future issues.

In concluding the discussion on this, no doubt the worst insect pest of the nursery, it is urgently recommended that those nurserymen who have not as yet had trouble from this pest, that they be steadily on their guard for its first appearance and no pains should be spared in taking every precaution in the fumigation of all propagating stock and in spraying with proper solutions, and in employing up-to-date methods in the conduct of the nursery.

To those nurserymen who have in the past experienced losses from the presence of this pest it can only be recommended that they continue the vigorous precautions and methods followed in the past. The nurserymen of this state can rest assured that the officers in charge of the inspection and control of this pest will give them all the support in their power to enable them to keep their premises clean and thus promote their business and protect their patrons.

THE WOOLLY APHIS.

This common and easily recognized pest is known by all nurserymen. Since it affects only apple it is not nearly so serious as the San José scale, yet it often is the cause for the discarding of many hundreds and sometimes thousands of trees. Its principal injury is to the roots of nursery trees although it is often found attacking the branches and foliage.

Practically all nurseries growing apple trees are attacked to a greater or less extent. It is most common on trees planted in new ground. It is best to destroy trees badly attacked with this pest, but where a slight attack is apparent on the branches throughout a block, spraying with a contact insecticide in the form of kerosene emulsion or strong tobacco decoction is usually a very satisfactory treatment.

The control of the pest when attacking the roots of trees is rather difficult, in fact it may be stated that there is not yet a thoroughly practical remedy. In nursery practice it is usual to discard all trees, whose roots have been badly injured by the pest and the fumigation of all trees with hydrocyanic acid gas before shipping usually kills any aphis that may be present and prevents further injury. The abundant use of tobacco dust around nursery trees will serve to prevent the presence and injury from this pest, and as this material has qualities as a fertilizer for the trees it may be profitably used in a nursery subject to woolly aphis. It can either be placed along the rows when the apple seedlings are planted or later when the stock is budded or grafted. Saturating the soil around the roots of apple trees with a dilute solution of kerosene emulsion is recommended by some authorities. This is suggested as especially adapted to old apple trees, but this treatment has not been sufficiently tested to recommend its use in the nursery. Continued experiments are being conducted against this pest in the nursery with a view of securing a more efficient remedy.

THE BLACK PEACH APHIS.

Similar in habits to the woolly aphis of the apple in occurring in both aerial and subterranean forms the black peach aphis differs in being dark in color and lacks the white cottony excretion which envelops the abdomen of the larvae of the woolly aphis.

Injury by this pest in the peach nurseries seems to be on the increase. The injury to peach roots is not so pronounced in causing a knotty appearance as is the case with the woolly aphis of the apple, yet their continued attack by sucking the juices from the roots and also from the foliage devitalizes the trees. Its presence on the roots is often unsuspected, the failure of such trees being attributed to other causes. When this pest has already become established on the roots of trees its control is often quite difficult. Heavy dressings of kainit is recommended as effectual in killing the aphids. Also unleached wood ashes placed along the roots of the trees has proven efficatious, while the free use of tobacco dust applied around the roots after the soil has been removed will be found to be one of the best means of control. Spraying the foliage with kerosene emulsion is usually a satisfactory treatment.

GREEN APHIS OF THE APPLE.

No injury is so common in the nursery as that caused by the several species commonly known as green aphis on apple foliage. The aphis may appear in early spring when the foliage is out and immediately causes the leaves to curl.

Quite often these insects do considerable damage in retarding the growth of nursery trees. Remedies should be applied to control them upon their first appearance. Kerosene emulsion, about 15%, sprayed on the foliage has proven effective in controlling these aphids, but no doubt we have a more satisfactory remedy in the tobacco decoction, known as "Black Leaf." This solution should be used diluted with cold water, one part of Black Leaf to 40 or 50 parts of water. These remedies can be used for all species of aphids found affecting the foliage of decideous trees.

THE OYSTER SHELL SCALE.

This scale insect is commonly found in the nursery attacking lilac bushes, apple, maple and other trees. It is not nearly so injurious as the San José scale inasmuch as there is usually but one generation throughout the year. In contrast to the San José scale this scale insect winters in the egg state, nevertheless, treating infected plants with a caustic wash such as the lime sulfur during the dormant season, will corrode the scale and allow the eggs to be washed out by rain or otherwise destroyed. Treatment with kerosene emulsion, 15%, can be employed about the middle of May when the eggs hatch. This will be found very effective and is advisable when dormant spraying is not practiced.

THE SCURFY SCALE.

Similar in habits to the oyster shell scale, this whitish scale is often found attacking the bark of apple trees in the nursery. It is not a serious pest, however, and can easily be controlled by the same remedies employed for the oyster shell scale.

CATERPILLARS.

The larvæ of several insects may be found at various times during the growing season attacking foliage of various plants in the nursery. Much injury is sometimes occasioned by such pests when allowed to continue their ravages unmolested. In combating such insects, when it is practical to employ an insecticide, some form of an arsenical should be used according to formula given below.

FORMULAS OF COMMON INSECTICIDES.

In combating insect attacks it is of prime importance that the grower be able to distinguish the manner in which the insect does its injury. There are two main divisions, first, insects that do their injury by eating, in combating which it is usual to employ a stomach poison, and secondly, insects which do their injury by sucking the juices of the plants, in which case it is usual to apply contact insecticides, gases, etc.

PARIS GREEN.

Paris green ¼ to ⅓ pound in 50 gallons of water. This well-known arsenical is commonly used in combating biting insects. While there are other arsenicals which are cheaper and possibly their purity can be more depended upon, yet this is a widely known insecticide and it is generally recommended by entomologists. Often it is well to add 4 to 5 pounds of slacked lime to the 50 gallons of water when paris green is used alone, in order to prevent any possible injury to foilage by burning.

Paris green is often combined with bordeaux mixture, a fungicide, in the same proportions as with water. The combination is then a fungicide as well as an insecticide.

ARSENATE OF LEAD.

This arsenical is used by many in preference to paris green as it is less caustic and not so liable to injure foliage and it remains in suspension and adheres to foliage for a longer period. It is usually recommended to be used at any strength, from 1½ to 6 pounds to 50 gallons of water. Recent tests, however, on young peach and plum foliage at 2 pounds to 50 gallons of water would indicate that the use of this strength on these plants should be conducted cautiously, in fact, it is better to use only one pound to the 50 gallons of water.

This product is sold by many manufacturing chemists and its quality is fairly reliable.

GREEN ARSENOID.

This powder is somewhat lighter than paris green and probably superior to it in composition. It also remains in suspension for a longer period. It can be used in the same proportions as paris green.

LIME-SULPHUR WASH.

Fresh stone lime	20 pounds.
Flowers (or flour) of sulphur,	15 pounds.
Water to make	50 gallons.

Boil 20 gallons of water in an iron pot or hog scalder, then add the 20 pounds of lime, also the sulphur, which should have been previously mixed with a little hot water to form a paste. The mass should be cooked vigorously until the sulphur is thoroughly dissolved, and a clear amber colored solution is produced. This usually requires about 30 minutes. Then add sufficient hot or cold water to make 50 gallons and apply warm.

KEROSENE EMULSION.

Kerosene	2 gallons.
Common soap	½ pound.
Water	1 gallon.

Dissolve the soap in boiling water, add the kerosene and emulsify by violent churning. Dilute to the required strength.

PATENT INSECTICIDES.

There are many so-called patent washes on the market. The grower is urged to be careful in employing any new wash. Try it in an experimental way on a small portion of your orchard, nursery or other plants, unless you can secure reliable information as to its effectiveness without injury to the plants.

WHALE OIL SOAP.

As stated previously this soap should be used at the rate of 2 pounds to the gallon of water for treatment against scale in the nursery. During the growing season, it can be applied only to the trunks of trees. During the dormant season it can be sprayed over the whole tree. When used in the latter manner it is best to apply it in early spring just before the buds open.

TOBACCO.

Tobacco is used in many ways as an insecticide. Old tobacco stems are often steeped in hot water, a pound of the stems to a gallon or two of water, the solution being used as a spray against aphids. The manufactured product known as "Black Leaf" is no doubt preferable and more satisfactory. It is used at the strength of one part of the solution to 40 or 50 of cold water.

Tobacco dust is a good material to place around the roots of trees when planted to prevent injury from root aphids. A couple of handfuls to the tree is usually sufficient. The burning of tobacco stems in a greenhouse is helpful in destroying several pests.

HYDROCYANIC ACID GAS.

This gas has come into use of late years as an important insecticide. Its use in fumigating nursery trees to prevent the distribution of the José scale has become quite general. It is made by combining the following:

Cyanide of Potassium, 98 per cent	1 ounce.
Sulphuric acid (commercial)	2 ounces.
Water	4 ounces.

This formula will fumigate an enclusure containing 100 cubic feet. Place acid in an earthen jar then add water and cyanide. Be sure to have the room or enclosure air tight, or nearly so. Keep everything closed for at least 30 minutes. This formula will serve to fumigate nursery trees, but in fumigating buds, etc., it should be reduced one third, using ⅔ of an ounce of cyanide and a corresponding reduction in acid and water. It is a very deadly gas and much care should be exercised in its use.

Often a small box is used for fumigating buds, grafts, etc. When it is desired to fumigate in such small enclosures it is best to send the three dimensions of the box to the Experiment Station and have the amount of materials estimated and the formula prepared for it.

BISULPHIDE OF CARBON.

This liquid is used in destroying stored grain insects and the like, and also some pests under ground, but principally the former. The liquid evaporates very rapidly, the gas being deadly to animal life when confined in it for any length of time. In fumigating grain or other similar material use one to three pounds of the liquid to 100 bushels of grain. The gas is exceedingly explosive; therefore do not allow any light, cigar or pipe around the building when fumigating. It is sometimes injected into the soil around the roots of the plants to destroy certain pests. In such cases a tablespoonful of the liquid injected a short distance from the plant would be sufficient. The gas is heavier than air and consequently it will sink into a pile of grain or down into the earth.

CONTROL OF PLANT DISEASES IN THE NURSERY.

Variations from the ideal in the production of nursery stock due to unfavorable climate, soil, etc., occur from year to year and must be provided for by proper cultural methods. Though unexpected loss often comes from outbreaks of disease, the profit in growing nursery stock is often decreased by fungi and other parasites which are so common that they are not regarded, the early leaf fall or lack of growth being considered normal, when in fact it might have been prevented by spraying. This is particularly the case with the leaf diseases due to parasitic fungi.

LEAF DISEASES.

The importance of the leaves must be recognized, as they are among the most essential parts of the plant. Every particle of material for growth, must be prepared in the leaves before it can be used to increase the diameter or produce new branches or roots on young trees; so that for healthy growth it is necessary to have an abundance of leaves, and the longer they remain on the longer growth can continue. Where the season is short and the annual growth must necessarily be small, this is of all the greater importance; but in this state the leaves may sometimes remain on the trees longer than is desired. However, even here, in many cases the loss of growth is very noticeable, due to the early fall of leaves from the effects of fungous diseases.

It was demonstrated many years ago by experiments conducted by the United States Department of Agriculture in Maryland and New York, that spraying with bordeaux mixture five to seven times during the growing season is a great benefit in preventing the early fall of leaves so common on many varieties of nursery stock. The diseases of this character that are most noticeable are the leaf blight of pear (which, of course, must not be confused with the twig-blight, or fire-blight of pear, mentioned later and due to a different cause), the scab, mildew, leaf-spot, and rust of apple, the mildew and leaf-curl of peach (the leaf-curl, however, occurring only in the early part of the season, and the mildew being bad only on a few varieties, such as Tillitson), the leaf-spot of cherries and plums and the mildew of grapes. Practically all of these could be controlled by proper spraying with bordeaux mixture, and many of our nurserymen put it into practice every year, some of the larger nurserymen keeping a sprayer going nearly all of the time during the summer.

The peach leaf-curl is as a rule not serious in the nursery, and the greatest loss in Maryland nurseries is due to the leaf-blight of pear, which frequently causes the loss of all of the foliage before the middle of August, and the cherry leaf spot which also causes the leaves of the cherries to fall very early in the season. Many of the plums are affected in the same way; the spraying of the plums with bordeaux for the leaf-spot can hardly be advised, however, as many varieties are injured by it. The peach is also very sensitive to this preparation, and if it is used at all outside of the dormant season, must have a great excess of lime; say, three pounds of copper sulphate to eight or nine pounds of lime in fifty gallons of water, but some of the lime and sulphur mixtures can be safely used to better advantage.

The grape mildew is usually very serious, especially on certain delicate varieties, and the death of a great many plants in the nursery is largely due to the loss of strength from the effect of this mildew on the leaves; and the spraying of grape stock would be one of much benefit to the nursery.

NURSERY SANITATION.

Cleanliness in the nursery is one of the most important things in controlling diseases, although the spraying mentioned is not to be neglected. A great many of the diseases found on nursery trees are also found on wild trees which may be growing in the vicinity. The ideal place for a nursery would be away from all woods and orchards, and the hedgerows and fences should be kept clean from all shrubbery liable to carry disease or insects. The leaf diseases which have been mentioned, although perhaps being the cause of loss of growth more than anything else, are comparatively easy to control, when the diseases of the stem are taken into consideration. The black knot of plum is perhaps the worst of these that has to be contended with here although it is uncommon on nursery stock. Old wild-cherry trees carrying knots of this disease as big as a man's body, are often seen standing along the fences in nurseries offering every chance of infection to the young stock. Cedar trees, so common along fences where they grow up naturally from seeds left there by the birds, cause the infection of many varieties of apple with the leaf rust, which comes from the other stage of this fungus in the so-called cedar apples. This leaf rust is difficult to control by spraying, and could be largely prevented by the removal of the cedar trees from the neighborhood.

It is no doubt necessary to have trial orchards in connection with nurseries, but orchards, and especially old worthless trees standing around the nursery, are simply infection points for fungous diseases of different kinds, and always are an indication of lack of care in growing the stock to any person visiting the nursery. A nursery should be entirely removed from all old trees of any kind, since they are likely to be full of fungous diseases and insects, unless especially well cared for. The stock held over by nurserymen, especially the smaller nurserymen, and heeled in near the growing stock, is also a menace of this kind, as it is usually of less vitality and so more liable to be infected early by fungous diseases which may then pass to the young stock.

Where it is not possible to have a nursery away from the woods and orchards, the trees especially to be looked out for and removed are those which are closely related to the cultivated stock, such as wild cherry, plum, hawthorn, crab apple, etc., and those which carry other stages of parasitic fungi, although not related, such as the cedar, which is a host of the apple-rust.

DISEASES OF THE WOOD.

The anthracnose of the raspberry sometimes occurs in the nursery, and although some good can be done by spraying with bordeaux mixture, the better method would be to carefully select healthy stock for propagation, and if the raspberry fields in the nursery became infected, to start other blocks, taking particular care to set with healthy plants, in other parts of the nursery distant from the infected places. The orange-rust of blackberry and raspberry also needs special care to prevent its spreading. It can hardly be treated by spraying, but all the diseased plants should be destroyed, even to the roots, in which the fungus passes the winter.

The twig-blight or fire-blight of apple, quince, and especally pear, needs special treatment. It is most common on trees which have bloomed, since it is more easily introduced by bees through the flowers; but, as is well known, it occurs frequently in nurseries of young trees. It usually appears in the latter part of summer, and although not often abundant enough to cause much loss in the growth of the trees, the nurseryman must look out for it to prevent its further spread and its being carried to his customers' orchards. The blight can best be controlled by cutting out the blighted twigs and branches in the latter part of summer, cutting six to ten inches below the lowest visible marks of the disease on the bark and frequently disinfecting the knife; or, if not abundant, perhaps cutting off the infected trees entirely. It is especially important that pear varieties susceptible to the blight should not be grown near old orchards of apple or pear, where this disease is liable to be present, and especial care must be taken to keep the blight out of the old trees, the many cases in the old bark requiring close search to find them.

Another wood disease is the plum canker, showing as sunken decayed spots, extending through the bark and wood of certain plum varieties. Such trees should be discarded and propagation made from healthy ones.

Peach yellows, while often introduced from the nursery, has been but rarely seen in the young trees. The disease may be present and not show symptoms for some years. It has been demonstrated that this disease is easily propagated by taking buds from diseased peach trees, and even from trees which do not at the time show the disease, but develop it in a few years; and as a rule, nurserymen are careful not to use buds from affected orchards. It is a common practice, also, to use the pits from seedling trees from regions where yellows is not found; particularly from the southern part of the United States, as a means of preventing the disease in nursery trees, but plenty of yellows in natural peach trees has been found as far South as the Tennessee and North Carolina mountains. From the tabulation of reports on thousands of orchard trees, obtained from the different nurseries in Maryland, and in some other states, no particular difference in the number of trees developing yellows from different nurseries has been detected.

ROOT TROUBLES.

The root diseases of trees in the nursery are among the most aggravating forms of unhealthy conditions, especially the crown gall, which has caused much trouble and loss to nurserymen. Recent investigations have shown that a number of distinct troubles have been confused with this name, and that the softer crown gall on certain kinds of trees like peach, and some species of plum, as well as raspberry, although in these cases very injurious, is probably distinct from the disease to which the same name has been applied on apple. This hard, woody gall near the junction of the stem and root of apple stock is not very contagious, however injurious it may be to further growth of the tree. Another form which is best known as hairy root, causes a stunted root system and the development of stiff root branches from the main root, totally distinct from the natural fibrous roots. The affected roots in most cases die, and the further root growth of the tree is supplied by new roots developing above the affected portion.

Unfortunately, there is no very practical means of controlling these diseases in the nursery, although a few years' further investigation may yield something of value. Even if the hard galls do little injury to the apple the affected ones can hardly be called perfect trees, and many observers think that they have seen a decided injury in the orchard from the planting of such trees. The trees affected with the galls are certainly more likely to send up sprouts from the base of the trunk, which is some indication of lack of healthy growth in the main tree. The hairy root, as well as many of the galls, may be avoided by careful selection of seedling stock, which if diseased, shows already the effect in the development of the stiff fiber, or rough bark. Buds or cions from diseased trees are also more apt to develop the disease. Anything but perfectly healthy roots should be thrown out and not used for propagation. Careful wrapping of grafts or budding is a further prevention.

The common crown gall on the peach, plum and raspberry is quite distinct and injurious. It is quite infectious, and ground that has been planted in trees affected with this disease should not be used for some years for the same stock, and great care should be taken in propagating not to communicate the disease with knife or by contact with roots from diseased fields.

PREPARATION OF FUNGICIDES.

BORDEAUX MIXTURE.

Bordeaux mixture is used more than any other substance to prevent plant diseases. It is made of copper sulphate (blue stone) dissolved in water and mixed with stone lime slaked in water. There must be enough lime to combine with all the copper sulphate so that it will not injure foliage, otherwise the proportions may vary considerably for different purposes.

Copper sulphate	3 to 5	pounds.
Lime	5	pounds.
Water	50	gallons.

Dissolve the copper sulphate by immersing in a bag hung in the top of a vessel of water for several hours, and dilute to twenty-five gallons of water, a half barrel can be used to hold it. Slake the lime in a similar vessel and dilute to twenty-five gallons. Pour the two together through a strainer into the sprayer. The bright blue liquid resulting is bordeaux mixture. The lime should be kept stirred, as it settles quickly. The copper sulphate will act on iron and some other metals. Brass or wooden vessels should be used for it. The milk of lime and copper sulphate solution should not be mixed while hot or before diluting. They will keep indefinitely before mixed, but the bordeaux mixture should be used the same day it is made.

Where several barrels of bordeaux mixture are to be used, the use of stock solutions will save much time. These are made by dissolving fifty pounds of copper sulphate in fifty gallons of water in one barrel, and slaking fifty pounds of lime and diluting it with fifty gallons of water in another barrel. Then, for making bordeaux mixture take as many gallons as pounds of each substance desired, dilute and mix as before. Evaporation from the stock solutions must be avoided and they must be thoroughly stirred before using from them. When proper water supply is at hand, the stock barrels, diluting tubs, etc., can be arranged on an elevated platform so the liquid can be passed from one to the other from spigots, and then run in similar manner through hose into the sprayer thus saving much time and greatly facilitating the work.

The properly prepared bordeaux mixture should have a bright sky-blue color. If the lime is poor it may have a greenish cast, and is then liable to injure foliage. It can best be tested by dropping a little solution of yellow prussiate of potash into the mixture. If a reddish brown color results, add lime until the test repeated shows no brown color. It is better to add more lime than enough to combine with the copper sulphate. Bordeaux mixture is an excellent medium in which to apply arsenical insecticides.

Bordeaux mixture for use on peach and plum foliage or other plants liable to injury by the stronger mixture used for most crops, is made in a similar manner by the following formula:

Copper sulphate	3 pounds.
Lime	9 pounds.
Water	50 gallons.

One must be sure the lime is good, as with this excess of lime, the before-mentioned test would not be practicable.

SULPHUR.

Sulphur is an excellent fungicide. It is used in the form of "flowers" or "flour" of sulphur. The former is usually better for applying in the dust form for mildews, asparagus rust, etc. The fumes from burned sulphur are used in disinfecting buildings, but are very destructive to live plants. Whitewash may be given disinfecting properties by mixing sulphur with it. The lime sulphur wash used for dormant treatment for insects acts at the same time as a fungicide; but the sulphides it contains are injurious to foliage.

A lime and sulphur mixture has recently been used with considerable success as a summer spray for diseases of foliage and fruit. This will probably prove a very satisfactory treatment for nursery stock. This mixture is not cooked sufficiently to form sulphides in injurious quantities, but the sulphur is held by the lime and acts slowly in keeping down diseases. The usual method is to slake 10 to 15 pounds of lime, stirring in 5 to 10 pounds of sulphur while it is hot and dilute without other heating with water to make 50 gallons. The mixture may be cooked some by the slaking lime, but should not be heated enough to give more than a faint yellow color to the liquid before it is diluted.

SPRAYING OUTFITS.

For a general discussion of spray pumps and apparatus for use in orchards, etc., the reader is referred to Bulletin 115 of this Station which can be had for the asking.

For spraying in a nursery, special apparatus or rather special mechanical arrangements are necessary for satisfactory work. The barrel sprayer is most commonly used in nurseries. The barrel and pump should be mounted on a special two-wheel rig of sufficient height to permit it to go over the tops of nursery trees without injury. Some rigs are so made that the rows of trees pass between a high arch in the axle. The pump may be worked by hand or geared to the wheels similar to many special potato row sprayers. In fact the special row sprayers can be used with advantage in the nursery when the stock is small. These sprayers are fitted to spray two or four rows of plants or stock. When the nursery stock grows large the rig referred to above usually sprays two rows; both are one-horse rigs.

Power sprayers other than the geared sprayers can be sometimes used in nurseries to advantage, especially when the stock is small, but the employment of such apparatus will usually depend on the quantity of stock to be treated.

The conditions under which spraying is done are so varied that only general recommendations can be made, and each individual will have to select that which his judgment dictates is best adapted to his conditions.

SPRAY PUMP MANUFACTURERS.

The catalogs of most firms are well illustrated, and it is wise for those anticipating purchasing a pump to secure these from many firms and select the one suited to his work. To this end the following list of manufacturers and dealers in pumps and supplies is given:

Griffith & Turner Co., Baltimore, Md.
Gould's Mfg. Co., Seneca Falls, N. Y.
The Deming Co., Salem, Ohio.
Morril & Morley, Benton Harbor, Mich.
Field Force Pump Co., Elmira, N. Y.
Myers Pump Co., Ashland, Ohio.
Geo. H. Stahl, Quincy, Ill.
Spray Motor Co., Buffalo, N. Y.
L. H. Orndorff, 203 7th Street, Washington, D. C.
F. W. Bolgiano & Co., 935 B Street, Washington, D. C.
Brant Mfg. Co., Chisago Falls, Wis.

MARKETING OF NURSERY STOCK.

Too much importance cannot be assigned to this phase of the nurseryman's business. Often his success or failure will depend upon the proper handling and distribution of the stock. Furthermore, the handling of the stock during the digging and packing season affords an excellent opportunity for mixing varieties unless systematic methods are employed in the conduct of the work. Nothing will bring a nurseryman into disrepute more readily than for his customers to be disappointed in the varieties they had selected.

To meet the demands of orchardists who invariably request that trees be shipped in early fall, when wished for fall planting, the nurserymen have gradually commenced digging earlier and earlier in the fall, until now it is common practice to strip nursery trees of their foliage, and about the last of September or early in October they start digging for early shipments. Depending upon the season, this practice no doubt tends to weaken the trees to some extent. Nursery trees should not be dug until they are assuming a dormant state.

There are various methods of digging, and it is not for us to advise which is preferable, as the nurserymen must employ that which is most convenient to his circumstances. The use of the "tree digger" is no doubt very desirable, as after it has been drawn under the trees they are much easier removed. Care should be exercised in its use in order that an undue amount of roots are not mutilated.

During the digging period in a large nursery, the foreman and men who attend to spraying and other such work in the nursery, should be at the digging field and all trees should be handled by this force before being carried to the packing house. No matter how carefully a nursery is conducted, there will be many trees in the nursery row which are unsalable. Woolly aphis or crown gall may be present on the roots or other injuries apparent which will be sufficient cause to discard trees. They will then be destroyed in the field, and there will be no risk of their escaping notice in the rush of getting out shipments at the packing house. This procedure is insisted upon if the presence of San José scale is suspicioned.

Again during this operation of digging too much stress can not be laid on the importance of keeping the roots of the trees out of the burning sun. There is no doubt, in the writers' opinion, that many healthy, strong trees are thus injured by their roots being exposed to the air and sun before they reach the grower's hands. Not only should this be prevented in the field or on the wagon, but also in the packing house. The wind will dry the roots of trees even if they are in the shade. The writers' fully believe that injury sometimes charged to fumigation is invariably caused by carelessness either on the part of nurserymen or orchardists in allowing the roots of trees to be unduly exposed.

The character of packing shed and the manner of handling the stock at this stage in the conduct of the nursery business is a subject which we are not prepared to discuss or offer suggestions concerning, as the financial status of the nurseryman will largely determine the conveniences which he employs for handling the stock. For large nurseries the packing house should either be located near the railroad track or a switch run to it. It should be so arranged that cars can be loaded direct from the packing house. The nurseryman is fortunate who can afford to have a large packing and storage house which will afford sufficient space for holding all the stock that he anticipates disposing of during a shipping season. It is usually more convenient to dig and store nursery stock of all varieties in the fall. The ground is in better condition for digging than it is in the spring and there is usually more time in which to do the work. This done in the fall, there is more time in the spring for other work which is perhaps urgent. In such case, care must be exercised in storing away the nursery stock so as to prevent heating. Any house for this purpose should be judiciously ventilated. Much stock is injured by heating especially if packed in a cellar without proper ventilation.

FUMIGATION.

Under all circumstances a nurseryman should be provided with a convenient and well constructed fumigatorium, as every bundle of trees should be fumigated with hydrocyanic acid gas. Too much importance cannot be attached to this treatment of all stock of deciduous trees, even if there is no reason to believe that the stock is affected by any insect pest. Extensive experiments conducted by a number of reliable persons extending over many years has demonstrated conclusively that fumigation with hydrocyanic acid gas will not injure trees if properly conducted and further it is without doubt the most effective preventative of the distribution of any insect pest. The fumigation of the stock should be one person's business and he should be well trained in its operation. The size of the fumigatorium of course depends upon the amount of stock handled. Often it is very convenient to have two houses or rooms built in the packing house. In this connection, it may be added that all nurserymen should have a small fumigatorium in the form of a box, in which can be fumigated all buds, grafts, seedlings, etc.

The construction of the large fumigatorium will depend on circumstances. Some prefer a house large enough and so constructed that a wagon loaded with stock can be driven in it and left standing in order that the stock may be fumigated without an additional handling. This form has not proved entirely desirable in this state. Others take the form of a closed room either adjoining or built within the packing house. No matter what its shape may be, it should be carefully constructed in order to be practically air-tight.

In fumigating nursery stock, the trees should not be packed tightly in the room as this will prevent a free diffusion of the gas. Also a proper location in the fumigatorium should be selected to set the jar or jars in which the gas is generated.

Any one anticipating building a fumigatorium should consult this Station before doing so, as experience in such work affords opportunity for future improvements.

Finally, every precaution should be taken in the packing house to prevent the mixing of varieties, especially in getting up small shipments. All stock should be carefully scrutinized by expert eyes to detect any unsalable trees from passing by. Great care must be exercised in the packing of trees in carload lots, to prevent their roots from drying out or other injury. Shipments should not be sent out by nurserymen during a season when they are likely to arrive at their destination under adverse conditions of weather, that is, particularly, during freezing times. For such conditions cause the orchardists much trouble and anxiety.

It is, of course, to be considered that under the most favorable conditions and best regulated business operations, mistakes by thoughtless employees will occur. But nurserymen in particular should employ every means to prevent as far as possible any error which will not only reflect upon their reputation, but also at times entail severe pecuniary losses by their patrons.

LEGAL REQUIREMENTS.

This heading could more appropriately be called legal protection for the sentiments expressed in the law under which the inspection of nurseries and orchards is conducted are plainly set forth as a means of benefiting the horticultural interests. Further, it was the efforts of both nurserymen and orchardists of the state that brought about its passage.

The officers of the State Horticultural Department, whose offices were created by the horticultural law, desire to commend the nurserymen of Maryland for the hearty coöperation they have given in having the requirements of the inspection law carried out. There has been a marked improvement in the condition and healthfulness of the nurseries during the past few years and we have no hesitation in stating that in our opinion the condition of the nurseries of Maryland are in no way inferior to those of any state in the East.

The same may be stated in respect to the orchardists of the state. We believe that there is more spraying and other treatment given for the control of injurious insects and plant diseases in Maryland for its area than any other state in the Union.

There will, however, continue to exist careless and negligent persons, and it is our endeavor to enforce the law to the letter in the case of the nurseryman or orchardist where the exigencies of the case require it.

INSPECTION OF NURSERIES.

As required by law the nurseries of Maryland are inspected every six months. Of necessity and rightly, the inspection conducted in late summer and early fall is the most important, for at this time there is an ample opportunity for the inspectors to examine all stock subject to sale. This inspection is not commenced until after the 20th of August. A certificate issued on an inspection made before this date in this latitude would manifestly be of little value, since in the case of the San José scale for instance, there would yet be time for two or three broods of the insect and consequent dissemination before the cold weather or fall. The inspection should be conducted as late as possible in order to be completed in time for fall trade.

The inspection in this state is conducted as thoroughly as circumstances and funds will permit. It is obviously impossible for the inspectors to examine every salable tree in a nursery, especially in nurseries where over a million trees are to be gone over. It only remains for the inspectors to go through the blocks as thoroughly as possible, satisfying themselves as to the condition of the trees. We usually arrange to go through the blocks in the opposite direction from which they were planted at an average distance of 20 to 30 feet between inspectors. Thus in examining trees closely from the ground up in each row at this distance apart the inspectors will invariably detect the presence of any injurious pest. In fact, in our experience we have not as yet had a single case of infestation by an injurious pest develop later which we had not located during the inspection.

Upon detecting the presence of any injurious pest in a block of trees likely to be disseminated, we at once closely inspect surrounding stock and blocks. All trees found infested are immediately destroyed, and no trees are allowed to be sold from blocks in which infested trees were found until after a hand inspection of all the trees is made. As a further precaution, of course, all trees sold from nurseries in Maryland are required to be fumigated with hydrocyanic acid gas as it is inevitable that some small scale hidden beneath buds should escape notice. Thus we believe that the inspection of nurseries in Maryland is conducted on as high a plane as is possible, and that such inspection offers as much protection to orchardists and other growers as well as to the nurserymen themselves as is practical in the operation of such a law.

As has been stated, Maryland nurserymen readily comply with the requirements made by the officers charged with the enforcement of the law, and no certificate is issued to any nurseryman allowing him to sell nursery stock until after such requirements and agreements have been complied with.

ORCHARD INSPECTION.

The officers of the State Horticultural Department have continually sought more effective means of not only being of more assistance to nurserymen and orchardists in the protection and promotion of the horticultural interests of the state, but also the most amicable, practical, yet rigid means of enforcing the law.

It was apparent that the orchards of the state should be inspected, and it was difficult to devise means for a proper inspection with the limited funds at our command. In justice to the nurserymen of the state the orchards in the respective vicinity should be regularly inspected. For a time the officers of the department endeavored to visit as many parts of the state as possible, but this procedure, while being a great help, did not promote the work as was desired.

Later, various local inspectors who had been given a course at the Agricultural College, were appointed to take up the local inspection of orchards. This scheme of orchard inspection has been in operation for the past six years and continues to be the most effective plan to reach all parts of a given territory. While it is possible to inspect only a part of the state each season, the work will gradually cover the whole state. The local inspectors have their allotted territory each year in their respective counties. They are thus enabled to visit each individual orchard and report its condition to the office of the department. They come in personal contact with the grower and can point out injury caused by any pest or disease and advise him as to treatment.

Furthermore, by this local inspection a better acquaintance with the conditions in each locality is acquired and enables direct attention to be given to direfully neglected cases, and cause treatment either by showing the great necessity of same or, if necessary, enforce the law.

Furthermore, the local inspectors can explain the work of the department to the orchardists, and show them that our efforts are directed towards helping them in the protection of their trees and the production of good crops, rather than in seeing the law enforced. Twenty-seven local inspectors are working in Maryland this season. Thus the inspection of nurseries and orchards are conducted in Maryland with little or no friction, and the horticulturists as a whole are ever ready to support the work of the department.

MARYLAND HORTICULTURAL LAW.

For the benefit of those unfamiliar with the law governing such inspections in Maryland we herewith give that part of the law of 1898, Chapter 289, relating to same for their information and guidance.

"55. That in order to accomplish the purposes of this Act, the State Entomologist and the State Pathologist, their assistants and employes, or any other officer, assistant or employe appointed by said board of trustees, are hereby authorized to enter upon any public premises, parks, cemeteries, or other premises, or upon any land of any firm, corporation or private individual within the State of Maryland for the purpose of inspection, destroying, treating or experimenting upon the insects and diseases aforesaid. Should any insect or disease found by said State Entomologist or State Pathologist, or by any other officer appointed by said trustees, be, in their opinion, capable of eradication without the destruction of the tree or plant, then said officers are to treat or cause to be treated with proper remedies and appliances all such trees, vines, shrubs, plants and grains. Further, said state officers shall treat or have treated, in order to prevent the dissemination of the aforesaid insects or diseases, any and all suspicious trees, vines, shrubs, plants and grains found to be in a dangerous proximity to those infested as aforesaid.

"56. That should any of the officers aforesaid, through their assistants and employes, or by any notification whatsoever, find any fruit trees, vines, shrubs, plants or grains, infested or diseased with the aforesaid insects or diseases, the aforesaid officers shall mark or tag in some conspicuous way, all trees, vines, shrubs, plants or grains infested with the aforesaid diseases and shall give notice in writing to the owner or owners, tenants or person in charge of such premises of the condition thereof, and thereupon, if such person or persons so notified shall not within ten (10) days after notification, destroy or treat the same in accordance with regulations and rules of said trustees, a copy of which will be sent on application to any person, then said trustees shall, through their officers, assistants or employes, destroy or treat all such trees, plants, vines, shrubs and grains, and the state officers shall file a statement of the expenses of such destruction or treatment with the trustees of said college, and said trustees shall transmit a copy of such statement and account of such expenditure, with the usual affidavit attached thereto to be made by the state officers, which shall be sufficient evidence to prove the claim to the State's Attorney of the county where the owner of such premises resides, and said attorney is directed to collect the same and account to the Trustees of the Maryland Agricultural College therefor.

"57. That it shall be the duty of said trustees to send the State Entomologist, or the State Pathologist, or their duly authorized assistants, at least once a year into each county of the State for the purpose of determining by inspection the healthfulness and general condition of the horticultural and agricultural interests.

"58. That it is hereby also made the duty of the said board of trustees, through the State Entomologist and the State Pathologist, or their duly authorized assistants, to inspect at least once in every six (6) months, all nurseries of trees, vines, shrubs and plants, subject to the aforesaid insects or diseases within the state, and if found free, so far as can be determined by inspection, from the aforesaid insects or diseases, to give to the owner or owners or persons in charge of said nurseries, a certificate of inspection showing such nurseries or premises to be apparently free from such insects and diseases. If any of the aforesaid insects or diseases should be found in any nursery or orchard, or any premises within the State where nursery stock is grown, the aforesaid officers shall cause to be destroyed or treated such portion of such nursery stock or other trees or plants as in their opinion may be necessary, and shall release all other nursery stock grown upon said premises, and issue a certificate of inspection to the owner or owners as herein provided for; and if such infested or diseased trees, vines, plants or shrubs be destroyed by the aforesaid officers, then the owners shall pay the cost thereof, and if he refuse to pay the same it shall be collected as prescribed in section 56. No nurseryman, broker, agent, dealer or other person shall be permitted to sell, ship, send out, or give away, by mail, express, freight or otherwise, any trees, vines, shrubs, plants, buds or cuttings from any such nurseries or premises, without accompanying the same, with a copy of the said certificate printed upon a tag or label not easily destroyed, the same to be firmly attached in some conspicuous position upon each carload, box, bale or package so sent out or delivered.

"SEC. 2. *And be it enacted by the General Assembly of Maryland*, That the following sections be and the same are hereby added to Article XLVIII of the Code of Public General Laws, title "Inspections," subtitle "Horticultural Department," to be designated as sections 59, 59A, 60, 61, 62, 63, 64 and 65.

"59. That should any nurseryman, agent, broker, dealer or other person send out or deliver within the state, or transport to any other State or Territory, or the District of Columbia, trees, vines, shrubs, plants, buds or cuttings, subject to the attacks of insects and diseases above provided for, without attaching a copy of said certificate, deface or destroy said certificate, or wrongfully attach a certificate, he shall be adjudged guilty of a misdemeanor, and shall upon conviction before any justice of the peace be fined a sum not less than ten dollars ($10.00) or more than one hundred dollars ($100.00) and costs of prosecution for each and every offense, and stand committed until such fine and costs are paid, and the fines so collected shall be paid to the trustees of the said college, and be added to the funds herein provided for carrying out the provisions of this Act."

The following form of certificate is issued to nurserymen whose nursery stock is free from dangerously injurious insects and plant diseases.

CERTIFICATE OF NURSERY INSPECTION.

No.......

To Whom It May Concern:

This is to certify, That on the........day of......190..we examined the nursery stock of....................growing in........ ....nurseries at....................County of................, State of Maryland, in accordance with the laws of Maryland, 1898, Chapter 289, Section 58, and that said nurseries and premises are apparently free, so far as can be determined by inspection, from the San José scale, Peach Yellows, Pear Blight and other dangerously injurious insect pests and plant diseases.

This certificate is invalid after..........190.. and does not include nursery stock not grown within this State, unless such stock is previously covered by certificate and accepted by the State Entomologist and State Pathologist.

....
State Entomologist.

....
State Pathologist.

College Park, Md...............190...

In accordance with the law every shipment or bundle of trees, plants, shrubs, etc., distributed must bear a copy of the above certificate. Growers should be careful to examine the certificate to see that it is issued during the year that he received the consignment.

VARIOUS STATE LAWS.

In the passage of laws protecting and fostering their respective horticultural interests, as is to be expected, there is considerable variation in their requirements. The conditions of our state are different from those in other states. Also, the prevalence of different insect pests and diseases will vary in a marked degree in the different states of the Union.

With the great increase of the nursery business and the consequent expansion of area covered by the trade, the requirements of different state laws upon outside nurserymen has steadily grown in importance and in some instances make a hardship upon them. Much agitation has been brought about looking towards a national law covering the shipments of nursery stock for interstate commerce. The existence of so many state laws seems a barrier to enacting a national law to meet existing conditions. There is no doubt, however, that such legislation is looking towards diversity in requirements instead of uniformity, and no doubt sooner or later there will be sufficient sentiment abroad which will either demand a national uniform law or vigorous efforts will be made to bring about more uniformity in existing state laws.

For the information of our nurserymen who sell nursery stock in other states of the Union we give here a summary of the requirements of the laws on the statute books in the respective states.

The officers of the department will gladly aid any nurseryman in the state who holds our certificate in complying with the law of any other state by filing certificates from their office or other details in meeting such requirements.

A list of the names and addresses of nurserymen who receive certificates from the department will be furnished upon application.

The requirements of the several states and Canada, relative to inspection, certification and transportation of nursery stock, as accurately as we have been able to secure, are briefly summarized below together with names of the responsible officers in each:

Alabama: A signed copy of inspection certificate must be filed with the Secretary of the Alabama State Board of Horticulture, Auburn, Ala. Accompanying the certificate must be sufficient money to pay for the necessary Alabama tags. A tag must be attached to every package of nursery stock delivered in the state. Tags are furnished at the following cost prices: First one hundred (100), 65 cents postpaid; two hundred (200), $1.00 postpaid; five hundred (500), $1.60; one thousand (1,000), $2.00, sent collect by express. Nurserymen must attach one of their own certificates as well as an Alabama certificate to each bundle of nursery stock. Also the following insects and fungous diseases are quarantined against: San José scale, new peach scale, woolly aphis, crown gall, black knot, peach yellows, peach and plum rosette. Prof. R. S. Mackintosh, State Horticulturist, Auburn, Ala.

Arizona: No law except that which refers to the inspection of date palms grown within the state or shipped in from other states or territories. Prof. R. H. Forbes, Director, Agricultural Experiment Station, Tucson, Arizona.

Arkansas: All shipments of nursery stock into this state must be accompanied by a certificate of inspection issued by the proper state official and bear the name and address of consignee and consignor. Prof. C. F. Adams, Entomologist and State Inspector, Fayettsville, Ark.

California: Shipments of nursery stock into California are held by the transportation companies until inspected by county horticultural inspectors. All packages must be marked with the name and address of the shipper, name of the consignor, and name of the place where the stock is grown. All nursery stock infested with pests not existing in California will be immediately sent out of the state or destroyed at the option of the owner and at his expense. Peach, apricot, and almond trees coming from districts where yellows and rosette are known to exist, shall be refused entry and shall be destroyed or returned to the shipper. Notices of shipment of nursery stock to California should be sent to the county inspector at point of destination, or to Mr. Edward M. Ehrhorn, Deputy Commissioner of Horticulture, Ferry Building, San Francisco, Cal.

Colorado: New law in effect January 1st. Requires all shipments into the state to bear a certificate of inspection. Also that all nursery stock shall be inspected by county inspectors before being delivered to purchasers, unless the State Entomologist notifies the inspectors that the stock from certain nurseries can be admitted without inspection. All stock must be fumigated with hydrocyanic acid gas. Prof. C. P. Gillett, State Entomologist, Fort Collins, Col.

Connecticut: All shipments of stock into Connecticut must bear certificates of inspection issued by state or government officers, and statement (which may be made by the owner) that the contents have been thoroughly fumigated. Dr. W. E. Britton, State Entomologist, Agricultural Experiment Station, New Haven, Conn. (Amended act of 1903).

Delaware: Shipments of nursery stock into the state must bear certificate of inspection and also certificate stating that the stock had been properly fumigated. All nursery stock not accompanied by proper certificates may be held by the transportation companies until it can be inspected. Prof. Wesley Webb, Secretary State Board of Agriculture, Dover, Del.

Florida: Non-residents, persons or corporations, who sell nursery stock in Florida, must pay a license tax of $25.00 per annum to the Collector of Revenue of the county in which the nursery stock is to be sold and obtain from the county judge a license to do business. This is understood to mean that canvassers or peddlers for nursery stock if non-residents, must secure a license in each county of the state, but there is no interfering with the shipment of stock into Florida. There is no law governing the inspection of nursery stock, but Florida nurserymen secure certificates from Prof. W. E. Berger, Entomologist, Florida Agricultural Experiment Station, Gainesville, Fla.

Georgia: Nurseries are inspected annually. A signed duplicate of inspection certificate, together with a signed statement by the nurserymen that all stock intended for Georgia will be fumigated in accordance with directions furnished them, must be filed in the office of the State Entomologist. Official tags of the Georgia State Board of Entomology will be furnished by the State Entomologist at the following price: One hundred tags, 60 cents postpaid; 200 tags, 85 cents postpaid; 300 tags $1.10 postpaid; 500 tags, $1.35 sent by express collect; 1,000 tags, $2.00 sent by express collect. Each shipment of nursery stock into the State of Georgia must bear the official tag of the Georgia State Board of Entomology, and also a duplicate certificate of inspection of the state from which the shipment is made. (Regulations adopted Jan. 26, 1906.) Prof. E. L. Worsham, State Entomologist, Atlanta, Ga.

Hawaii: Shipments are subject to the regulations of the Board of Commissioners of Agriculture and Forestry and are subject to inspection and quarantine on arrival at Honolulu, which is the only port where they are allowed to be landed. For application blanks for inspection and special information, address Hon. C. S. Holloway, Secretary, Honolulu.

Idaho: No person can engage in the business of selling, or importing nursery stock without filing a bond of ($1000.00) one thousand dollars, with the Secretary of the State Board of Horticulture, and receive a permit, to do business within the state. Shipments into the state must bear a certificate of fumigation signed by a person duly authorized by the state where shipment originated, each package should also show the names of the consignor and consignee, also place where stock was grown. Shipment of peach stock from sections where peach yellows or peach rosette is known to exist is prohibited. Prof. J. R. Field, State Horticultural Inspector, Boise, Idaho.

Illinois: Nurserymen or agents desiring to sell stock into this state are required to furnish to the State Entomologist annually a sworn statement showing that the stock in which he deals has been duly inspected, and must submit for approval a copy of the certificate of inspection. All shipments into the state must be accompanied by a certificate of inspection. Dr. S. A. Forbes, State Entomologist, Urbana, Ill.

Indiana: Nursery stock shipped into the state shall be plainly labeled with the name of the consignor and name of the consignee, and a certificate signed by a state or government inspector showing that the contents have been examined. Prof. Benjamin W. Doughlas, State Entomologist, Indianapolis, Ind.

Iowa: Shipments of nursery stock into this state must be accompanied by a certificate of inspection, a copy of which should previously be filed for approval with the State Entomologist of Iowa. Prof. H. E. Summers, State Entomologist, Ames, Iowa.

Kansas: Nurseries are inspected annually between June 15th and November 1st. Certificates are valid until the first day of the following June. No nursery stock shall be brought into the state nor offered for sale within the state without having been previously properly inspected. (Laws of 1907). State Entomological Commission, Topeka, Kansas. Prof. T. J. Headlee, Entomologist, Manhattan, Kan., Prof. S. J. Hunter, Entomologist, Lawrence, Kan.

Kentucky: A copy of the inspection certificate and also a list of the contents should be attached to each bundle or package of nursery stock shipped into this state. To avoid possible delays, etc., a copy of the certificate should be filed with the State Entomologist. Prof. H. Garman, State Entomologist, Lexington, Ky.

Louisiana: Nursery stock delivered within the state must be labeled with an official certificate of inspection based upon inspection on or after July 1st and made within twelve months preceding time of shipment. Where several orders of nursery stock are shipped to an agent in one consignment each individual order must be tagged. Shipments not so labeled shall be liable to confiscation. The Entomologist has power to require any one in the state to fumigate trees and plants if deemed necessary. (Laws of 1903, State Crop Pest Regulations, 1907.) Prof. Wilmon Newell, Secretary, State Crop Pest Commission, Baton Rouge, La.

Maine: All shipments of nursery stock into the state must bear a certificate of inspection, or any box or package bearing a certificate of fumigation which shall be an affidavit made before a Justice of the Peace that all stock sold by the Consignor has been fumigated in a manner approved by the State Nursery Inspector of the state from which said nursery stock is shipped, the same may be accepted as though bearing a proper certificate of inspection. Prof. E. F. Hitchings, State Entomologist, Waterville, Maine.

Maryland: Nurseries inspected at least once in six months. All nursery stock subject to attack of insect pests must be fumigated under the direction of State officials. Shipments into the state must be labeled with the name of consignor and consignee and each package bear a certificate of inspection. Duplicate certificates should be filed. (Chapter 289, Laws of 1898.) Prof. T. B. Symons, State Entomologist; Prof. J. B. S. Norton, State Pathologist, College Park, Md.

Massachusetts: Nurseries are inspected once each year and certificates are issued by the State Nursery Inspector. No nursery stock shall be sold in the state unless the owners hold an unexpired certificate of inspection, unless however, all stock sold shall be fumigated with hydrocyanic acid gas in the prescribed manner, or who shall treat the stock which they sell by some other method approved by the State Nursery Inspector and who shall make affidavit before a Justice of the Peace that all stock sold by them has been fumigated or treated and who shall attach a copy of such affidavit to each package, box or car of stock sold, shall be exempt from the requirement of holding a certificate of inspection. All nursery stock shipped into the state shall bear a certificate of inspection or a copy of an affidavit of fumigation which meets the requirements of fumigation above specified. (Laws of 1907.) Dr. H. T. Fernald, State Nursery Inspector, Amherst, Mass.

Michigan: Nurseries are subject to inspection: infested trees must be destroyed and the remainder of the stock within a half mile must be fumigated. Shipments into the state must bear on every package, plainly labeled, the name of the consignor and consignee, statement of contents, and a certificate showing that the contents have been inspected by a state or government officer, and if of species subject to the attack of San José scale must be fumigated with hydrocyanic acid gas, and certificates of fumigation must also be attached together with a certificate of inspection. This applies to individual orders when several are contained in the same shipment. All nurserymen whether residents of Michigan or other states, who wish to grow or sell stock within the state must apply to the State Inspector of Nurseries on or before August 1st of each year for a license, for which the fee is $5.00, and a bond for $1000 must be filed. A license will not be granted until a state or government inspection certificate has been filed. (Laws of 1905.) Prof. L. R. Taft, State Inspector of Nurseries and Orchards, Agricultural College, Mich.

Minnesota: There is an annual inspection of all nurseries from which stock is shipped out of the state. Shipments into the state must be accompanied by a certificate of inspection. Carrying companies accepting packages of nursery stock without a certificate of inspection are liable. (Laws 1903). Prof. F. L. Washburn, State Entomologist, St. Anthony Park, Minn.

Mississippi: Every person or firm from other states wishing to ship nursery stock into Mississippi must file a copy of their certificate with the Entomologist of the Experiment Station. This certificate must state that stock has been fumigated under the directions of the official issuing the certificate. A copy of the certificate must also be attached to every bundle, bale, package, etc., of nursery stock delivered within this state. Prof. Glenn W. Herrick, Experiment Station, Agricultural College, Miss.

Missouri: Nurseries inspected annually. Every package of nursery stock shipped into the state shall be plainly labeled with the name and address of the consignor and the name and address of the consignee, and the contents, and a certificate showing that the contents have been inspected by a state inspector or a State Experiment Station Entomologist of the state from which the shipment is made, to show that the nursery stock is free from San José scale, peach yellows, peach rosette, or other dangerously injurious insects or diseases. Transportation companies are forbidden to deliver nursery stock unless accompanied by a certificate. Prof. J. M. Stedman, State Entomologist, Columbia, Mo.

Montana: All stock brought into the state must be unpacked, inspected and fumigated at one of the designated quarantine stations, viz: Miles City, Billings, Dillon, Missoula, Kalispell, Great Falls, Troy, Plains, Glasgow or Thompson Falls. Nursery stock may be inspected and fumigated at other points of delivery on payment of all cost. To sell or deliver nursery stock it is necessary to first obtain a license by paying a fee of $25.00 and by filing with the Secretary of the State Board of Horticulture a bond in the sum of $1000 annually. Notice of shipment including an invoice of stock, should be sent to the Secretary of the Board, Prof. Jos. W. Wallisch, Secretary State Board of Horticulture, Hibour Block, Butte, Mont.

Nebraska: No inspection law, but certificate of inspection should accompany shipments into the state. Nurseries are inspected by Prof. Lawrence Bruner, State Entomologist, University of Nebraska, Lincoln, Neb.

Nevada: No law governing shipments into this state. Prof. S. B. Doten, Entomologist Experiment Station, Reno, Nevada.

New Hampshire: All nursery stock shipped into this state must bear a certificate of inspection upon each bundle or package. A satisfactory certificate of fumigation will be accepted in lieu of an inspection certificate. Prof. E. D. Sanderson, State Entomologist, Durham, N. H.

New Jersey: Shipments of nursery stock into this state must be accompanied by a certificate, signed by an official inspector, certifying that the stock has been inspected and found free from San José scale and other dangerous injurious pests. If the stock has been fumigated it should be stated on the tag. No licenses and no fee or official tags are required in the state. Dr. J. B. Smith, State Entomologist, New Brunswick, New Jersey.

New Mexico: No law relating to nursery inspection.

New York: All shipments of nursery stock into this state must be accompanied by a certificate of inspection and bear name and address of the consignee and consignor. All shipments may be inspected and fumigated by state inspectors. Copies of the law and further information can be obtained of (the enforcing officer) Hon. R. A. Pearson, Commissioner of Agriculture, Albany, N. Y.

North Carolina: Nurserymen shipping stock into North Carolina must be in possession of valid certificate of inspection, and a copy of this certificate must be attached to each shipment or delivery. A copy of this certificate must also be previously filed in the office of the Entomologist. It is not required that nurserymen shall secure tags from us to attach to their shipments and it is not required by law that stock coming into the state shall be fumigated, but it is greatly to the advantage of the nurserymen if he can give assurance that his stock has been thus treated. Prof. Franklin Sherman, Jr., Entomologist, Department of Agriculture, Raleigh, N. C.

North Dakota: No law. Prof. C. B. Waldron, Entomologist, Agricultural College, North Dakota.

Ohio: Nurseries are inspected each year, and certificates are issued which are valid for one year. Provision is made for the official certification and fumigation of nursery stock. Nursery stock shipped into the state must be labeled on the outside with the names of the consignor and consignee and be accompanied by an official certification of inspection or fumigation. Agents and dealers who sell stock within the state must file a sworn statement as to the source from which said stock was obtained and that it has been officially inspected. Mr. N. E. Shaw, Chief Inspector, Department of Agriculture, Columbus, Ohio.

Oklahoma: The owners or operators of nurseries who desire to ship stock into the state of Oklahoma are required to make an application for a permit. This permit is issued by the Board of Agriculture upon the filing of a duplicate certificate of inspection, or report of inspection from the State Inspector, who examined the stock, and in addition the application must be accompanied by a remittance of $5.00. If satisfactory the Board issues a permit over the signature of its secretary, and in addition to the above may require further evidence of integrity to establish the responsibility and good faith of the applicant. All shipments must be accompanied by a tag, on which is printed a copy of this permit over the fac-simile signature of the Secretary of the Board. All agents canvassing for nurseries located outside the state are required to carry a duplicate of the permit of their principal, which duplicate is issued upon payment of $1.00. Quotations on tags will be given upon application to the secretary. (Act of 1905.) Address all communications to the Oklahoma State Board of Agriculture, C. F. Barrett, Secretary, Guthrie, Okla.

Oregon: All shipments of nursery stock into this state must be inspected at quarantine stations or at point of destination before delivery to the consignee. The importation of peach trees from districts known to be infected with little peach or with peach yellows is prohibited. Mr. H. M. Williams, Secretary State Board of Horticulture, Portland, Oregon.

Pennsylvania: Shipments of nursery stock into this state must be plainly marked with the names of the consignor and consignee, and must be accompanied by certificates showing that the contents have been inspected and that the stock (excepting conifers and herbaceous plants) has been properly fumigated. Agents and dealers in nursery stock are furnished with certificates under certain restrictions. Transportation companies are required to reject all consignments entering this state unless certificates of inspection and fumigation are attached. Prof. H. A. Surface, Economic Zoölogist, Mr. E. B. Engle, Nursery Inspector, Harrisburg, Pa.

Porto Rico: Nursery stock will be received only through three ports of entry, namely, San Juan, Ponce, and Mayaguez, and must be accompanied with an official certificate of inspection. It is subject to inspection by local inspectors on arrival at said ports of entry. Inspectors are appointed by the Governor. (Act of 1905.)

Rhode Island: Nursery stock shipped into the state must bear an inspection certificate or a fumigation affidavit, and all stock not so labeled must be returned to the consignor. (Chapter 159 Laws of 1904.) Mr. A. E. Stene, State Nursery Inspector, Kingston, R. I.

South Carolina: Nurserymen residing without the state of South Carolina, but who are doing business therein, are required to file in the office of the South Carolina State Board of Entomology, Clemson College, S. C., their certificate of inspection and fumigation furnished to them by the entomologist of the state in which the stock is grown. To those who comply with the above requirements, the official tags of the Board are issued, upon order, at a cost of eighty-five cents for the first one hundred and fifteen cents for each additional one hundred. Prof. Chas. E. Chambliss, State Entomologist, Clemson College, S. C.

South Dakota: Out-state nurserymen desiring to do business in this state must first make application for a permit from the Secretary of the State Board of Agriculture accompanied with a fee of $10.00 and filing a copy of their official certificate in said office. Mr. C. N. McIlvaine, Secretary State Board of Agriculture, Huron, South Dakota. Prof. Robert Matheson, State Entomologist, Brookings, S. D.

Tennessee: Nurseries are inspected annually. Certificates are issued not later than November 1, and become void after August 1 of the following year. Parties shipping nursery stock into Tennessee must file duplicate certificate of inspection, signed in person by proper official, with the Secretary of the State Board of Entomology, Knoxville, Tenn. A certficate of inspection must be attached to each package of nursery stock shipped into the state. All nursery stock shipped or delivered within the state must be fumigated before delivery. Prof. H. A. Morgan, Secretary State Board of Entomology, Knoxville, Tenn.

Texas: Nurserymen desiring to sell stock in this state must first file a certified copy of the certificate of inspection issued by the state or government inspector showing that the stock has been examined and found apparently free from all dangerously insect pests and diseases, and where fumigation is required it must show that the stock has been fumigated. On filing such certificate a fee of one dollar ($1.00) is charged. All shipments must be accompanied by a copy of said certificate attached. Hon. R. T. Wilmer, Commissioner of Agriculture, Austin, Texas.

Utah: Any person, firm or corporation, selling stock within the state must first obtain a license from the State Board of Horticulture. Five dollars for any annual business below $1,000; $10.00 for any annual business over $3,000, and under $10,000; $50.00 for any annual business over $10,000, and by filing with the Secretary of the Board a bond in the sum of $500.00 conditioned that the principal will comply with the law and pay the cost of fumigating nursery stock imported or sold within the state, and the expense of destruction of any infected stock. Licenses are granted for one year. Shipments of nursery stock (except conifers and delicate ornamental plants) into the state must be accompanied by a certificate of fumigation or disinfection by hydrocyanic acid gas before shipment. (Law of 1907.) It shall be the duty of persons, firms or corporations to provide their salesmen or agents with a certificate of the State Board of Horticulture, stating the name of such agent and name and address of the firm they represent, together with the license number of such firm; to attach a copy of the certificate of inspection to each delivery of trees into the state; to file with the Secretary of the State Board of Horticulture, a statement of their annual business when making application for license, and when printed copies of certificates of fumigation are used, they shall file with the Secretary of the State Board of Horticulture a duplicate (not a copy) of the original certificate. (Rules, February 27, 1908). Mr. J. Edward Taylor, Secretary State Board of Horticulture, Chamber of Commerce, Salt Lake City, Utah.

Vermont: No law. Mr. Wm. Stuart, Horticulturist, Agricultural Experiment Station, Burlington, Vt.

Virginia: Nurserymen must file a copy of their certificate of nursery inspection with the State Entomologist, Blacksburg, Va. Application must also be made to the Auditor of Public Accounts, Richmond, Virginia, accompanied by certified check or draft for $20.00 drawn or endorsed payable to the Treasurer of the State of Virginia. Personal checks will not be accepted. A copy of the certificate of registration issued by the Auditor should be in the hands of each agent. These duplicates may be obtained free by applying to the State Entomologist. When stock is shipped into this state, each carload, box, bale or package must be accompanied by the official tag of the State Entomologist, which can be obtained at cost of printing by applying to his office. Prof. J. L. Phillips, State Entomologist, Blacksburg, Va.

Washington: No person, firm or corporation shall engage or continue in the business of selling as agent, solicitor, or otherwise, within the state, or importing nursery stock without first having obtained a license. Application therefor must be made to the Commissioner of Horticulture, together with a satisfactory bond of $1,000; each bond must be renewed each second year. Such bond shall be conditioned that the principal or his agents, will obey the provisions of the law, and that said principal will pay the cost of disinfection or destruction of all infested nursery stock and fruit sent into the state by said principal or his agents. The license fee for nurserymen and tree dealers shall be $5.00, and for other agents or salesmen $2.50. All licenses expire two years from date of issue unless renewed upon the same terms originally provided for. Every person licensed to do business in the state must notify the Commissioner of Horticulture of his intention of shipping nursery stock, giving the names and addresses of the persons, firms or corporations to whom they are sold. Such notice shall contain the name and address of both consignor and consignee, an invoice of the goods to be shipped and point from which they are to be delivered. A copy of such notice shall also be sent to the county horticultural inspector of the county in which the point of destination is located. For full information address Mr. F. A. Huntley, Commissioner of Horticulture, Tacoma, Washington.

West Virginia: Nurseries are inspected and certified once each year. Certificates are valid for one year from the 15th of September. No persons shall deliver any nursery stock consigned to points in the state from points without the state unless at least ten days before the time of delivery a notice in writing is given to the Director of the West Virginia Experiment Station, Morgantown, W. Va., of the number of trees in such consignment, and the place from whence such trees were shipped and the destination of the same, and said director may cause the inspection, fumigation or destruction of the said stock if found infested with San José scale or any infectious disease. (Laws of 1907.) Every person who employs traveling salesmen for the sale of nursery stock shall take out a license in some county of the state for which he shall pay a fee of $10.00 per annum. Every such principal shall file with the clerk of the county a list of all agents or salesmen. (Laws of 1905.) Mr. J. B. Garvin, Secretary, Board of Agriculture, Charleston, W. Va.; Prof. J. H. Stewart, Director Agricultural Experiment Station, Morgantown, W. Va.

Wisconsin: All shipments of nursery stock into this state must be accompanied by a certificate of inspection issued by the proper state or government official and bear the name and address of consignee and consignor. Prof. E. P. Sandsten, Inspector, Madison, Wis.

Wyoming: Any person or firm wishing to do business in this state must first obtain a license. Licenses are issued on application for a period terminating on July 1 of the next succeeding inspection year (approximately two years). All applications must be accompanied by the license fee ($25.00), a bond in the sum of five hundred dollars ($500) conditioned that the principal will faithfully obey the law of the State of Wyoming, and by a certified certificate of inspection from an authorized inspector in the state from which shipments are to be made. On receipt of these, the Secretary of the State Board issues authorized shipping tags (at cost). Nursery stock may not enter the state, and transportation companies may not deliver unless such tag be attached to each and every box, bundle or bale. The presence of the shipping tag shall be taken as prima facie evidence of inspection and no further inspection is required, though the Board reserves the right to reinspect if for any cause it may deem it wise to do so. Notice before shipment should be made to, and a circular of information obtained from Prof. Aven Nelson, Secretary State Board of Horticulture, Laramie, Wyo.

Canada: All nursery stock coming into this country from countries where the San José scale has been found, must be fumigated at one of the designated ports of entry by a federal official, at government expense. All nursery stock must be imported through one of the following ports of entry between the dates specified: Winnipeg, Man., and St. John, B. B., between March 15th and May 15th, or between October 27th and December 7th; Windsor, Ont., Niagara Falls, Ont., and St. Johns, Que., between March 15th and May 15th, or between September 26th and December 7th. At Vancouver, B. C., during the winter months only, between October 1st and May 1st. Dr. James Fletcher, Dominion Entomologist, Ottawa, Canada.

British Columbia: For this province all shipments of nursery stock will be inspected at the Inspection Station, Vancouver, B. C. Nurserymen are required to put up bonds in the sum of two thousand dollars ($2,000), and to take out licenses before being allowed to sell nursery stock in the provinces. Mr. J. R. Anderson, Deputy Minister of Agriculture, Victoria, B. C.

Ontario: All shipments of nursery stock from the United States into Ontario must come by way of Dominion fumigating houses at Niagara Falls or Windsor (see note above as to Canada). Sale of infested nursery stock is prohibited. All domestic nursery stock must be fumigated under supervision of officers of Provincial Department of Agriculture, Mr. C. C. James, Deputy Minister of Agriculture, Toronto, Ont.

NATIONAL LAWS.

As mentioned heretofore there is no national law governing inspection or transportation of interstate shipments of nursery stock.

There is also no law governing the inspection of imports or exports. It is hoped that such a law will shortly be enacted to prevent as far as possible the introduction of any new pests from other countries in such shipments.

INSTRUCTIONS TO OUT-STATE NURSERYMEN.

Section 60 of the Maryland law plainly defines the requirements of nurserymen outside of the state desiring to sell nursery stock in the state and is here inserted for their information.

"That when any trees, plants, shrubs, vines, buds or cuttings, commonly known as nursery stock are shipped into the state from any other state or territory, or the District of Columbia, to any nurseryman, broker, dealer, agent or other person in this state, every carload, bale, box or package thereof shall be plainly labeled on the outside with the name of the consignor, the name of the consignee, and a certificate showing that the contents have been inspected by a qualified state or government officer, and that the trees, plants, vines, shrubs or cuttings therein contained are apparently free from the insects and diseases herein provided for. Whenever any trees, plants, vines, shrubs, buds or cuttings are shipped into this state from any other state or territory, or the District of Columbia, without such certificate plainly fixed on the outside of each carload, box, bale or package, the agent of the transportation company, firm or person, receiving same shall not deliver said nursery stock to the consignee or agent representing the consignor, and said agent of the transportation company, firm or person, shall notify the State Entomologist or State Pathologist at the Maryland Agricultural College, and said state officer receiving such notification shall immediately notify any justice of the peace of this state to issue a summons for the consignee, and the agent or consignor, if he be known, of such carload, bale, box or package of nursery stock, to appear before him on a certain day to be named therein, to show why such trees, plants, vines, shrubs, buds or cuttings should not be seized as being in violation of the provisions of this Act, and on trial thereof, if said justice be satisfied that the provisions of this Act have been violated, said justice shall order said agent or consignee to return such carload, box, bale or package of trees, plants, shrubs, vines, buds or cuttings, immediately to the shipper or consignor, unless said consignee or agent of the consignor at his expense, shall forthwith have said nursery stock examined by the State Entomologist and State Pathologist of this state, and such officers certify to such justice of the peace that said nursery stock is apparently free from the insects and diseases mentioned herein, and tag every such carload, box, bale and package inspected by said officers, with their certificate of inspection, and if said agent or consignee shall fail to have said nursery stock examined by said state officials, or fail to return such carload, box, bale or package thereof, then said justice of the peace shall order and direct the constable or sheriff to burn and destroy all such trees, plants, shrubs, vines, buds or cuttings that have been shipped into this state in violation of this Act."

"61. That whenever any agent of a transportation company, firm or person, shall receive a carload, box, bale or package of trees, plants, shrubs, vines, buds or cuttings without a certificate attached, as provided for in Section 60 of this Act, and shall fail to notify the state Entomologist or State Pathologist of this fact immediately upon the arrival of such nursery stock, and before delivering the same to the consignee, said agent of the transportation company, firm or person shall be adjudged guilty of a misdemeanor, and shall upon conviction before a justice of the peace, be fined a sum not less than ten dollars ($10.00) nor more than one hundred dollars ($100.00) and costs of prosecution for each and every offense, and stand committed until such fine and costs are paid; and the fines so collected shall be paid to the trustees of said College to be added to the funds herein provided for carrying out the provisions of this Act. If any nurseryman, dealer or agent, sell, ship or deliver any trees, plants, shrubs or vines into or in this state, which is infested with San José scale, peach yellows, pear blight or other injurious diseases, and upon examination by the State Pathologist, State Entomologist or their assistants, is condemned by being so infested, the said trees, plants, vines and shrubs shall be destroyed, and the nurseryman, dealer or agent shall forfeit the value of such stock, and shall not collect the same from the purchaser or consignee."

All nurserymen who desire to do a business in this state should file with the State Horticultural Department, before making such shipments a copy of their nursery inspection certificate. We desire these certificates to determine, as far as possible, by whom the inspections were made. No tags from this department are necessary on shipments into the state. Simply attach copy of your certificate of nursery inspection, and shipments will be delivered by our transportation agents. It is not desired to in any way restrict the commerce of outside nurserymen in this state, but any violation of the above section will be immediately dealt with.

COÖPERATION OF RAILROAD AGENTS.

As will be seen in section No. 61 of the Maryland Law, that agents of all railroads or transportation companies are compelled to hold up any shipment of nursery stock either from within or without the state, that have not attached an up-to-date copy of an official certificate of nursery inspection, issued by a regular state official.

Failure on their part to report to this department any irregularity in the shipments of nursery stock will be considered a misdemeanor and shall upon conviction thereof be fined a sum not less than ten dollars ($10.00) and not more than one hundred ($100.00) and costs of prosecution for each and every offense.

We must have the aid and coöperation of all agents in the state in order to rightly perform our duties and prevent the dissemination of uninspected and uncertified stock.

RELATION OF FRUIT GROWERS TO NURSERYMEN.

The relation between fruit growers and nurserymen should be most cordial and candid for each must depend on the other. The nurseryman could not exist without his fruit grower customers, and on the other hand few trees would be planted if each man had to propagate his own. To be successful, the nurseryman must have the confidence of the fruit grower. There have been times when the fruit grower was justified in condemning the nurseryman in strong terms because the trees were not of the grade or variety purchased and paid for. There is nothing meaner in the whole business of fruit growing than for a nurseryman to sell and agree to deliver one variety, and then without the knowledge or consent of the customer to deliver some other variety, no matter if it is done by intention or by error. If the fruit grower wants to order Ben Davis apple trees it is the nurseryman's duty to deliver Ben Davis and nothing else. If he cannot furnish Ben Davis trees it is his duty to say so and then to obtain permission before substituting some other variety. It is a satisfaction to know that reliable nurserymen are honorable in this matter and may be depended on to deal fairly.

When a fruit grower decides upon planting trees he should make out a list stating what he wants; that is, the names of varieties, the number of trees of each variety, the age and size, low headed or high headed, root grafted or budded, and submit this list to the nurseryman asking first if he can furnish the trees as specified, and second at what price. Dealing direct with the nurseryman is best, then he can be held responsible if the trees are not as represented. Nurserymen who win the confidence of, and deal fairly with, their customers, need not worry about future sales. One honest deal will be followed by many orders.

As a rule it is best to deal with the nearest reliable nurseryman, then shipments will be shorter and freight or express bills less than when dealing with distant firms.

Personal acquaintance between nurserymen and fruit growers is most desirable.

Growers are warned against the practice of entering into a contract with a tree agent or nurseryman in paying a high price for the trees with the understanding that the agent or nurserymen will care for the trees for a number of years or until some commence bearing. In certain cases the agent has left the locality or the nurseryman closed out the business of the firm issuing these contracts, continuing the business under a new name. Such unreliable firms, and it may be added there are but few in the country, extort from the grower a high price for the trees with no intention of fulfilling their contract in caring for the trees, and if they do they are usually not in a position to give the orchard the attention that it deserves and requires.

Maryland growers may have confidence in the Maryland nurseryman as a whole, for we believe that the men engaged in the nursery business in this state have the interests of the purchaser at heart and will spare no means to give entire satisfaction.

Some of our nurserymen have large variety orchards fruiting which enables them to learn the characteristics of any comparatively new varieties and check upon the old. It also affords opportunity to secure vigorous buds for the nursery which is vital in the production of good trees.

Further, in but few instances have we experienced any irregularity by outside nurserymen. Most states have laws similar to ours and require all stock to be inspected and fumigated, and this Department requires the nurseryman wishing to do business in this state to first file a copy of his official certificate in this office. By this means we know who inspected the nurseries and also the firms that intend to do business in the state.

GROWERS AND THE LAW.

The Maryland horticultural law was passed at the instance of both growers and nurserymen of Maryland and its enforcement presents duties and obligations to both, as well as extends privileges and protection alike. The grower must protect the trees in the orchard from serving as a public menace in the distribution of any pest, the nurserymen must protect the trees in the nursery in order that their distribution will not disseminate injurious insects or diseases.

It is due the orchardist that in a contract with the nurserymen for so many trees at such a price, that he receive his money's worth of good sound, clean trees or plants; and ignorance on the part of the nurseryman in sending out diseased trees or plants is not excusable for breaking his contract with the orchardist. It is likewise due the nurseryman that he secure a reasonable profit from his business, and if the expenses in connection with keeping his nursery free from the various pests accordingly increases the cost of production, the price of good nursery stock must certainly increase at a corresponding rate. We believe in a thorough inspection of the nurseries and we believe that the nursery men as a whole are desirous of such an inspection being as rigid as possible. But it is due them that such inspection, together with the requirements following it, entail as little loss and trouble as is consistent in the distribution of good, clean, healthy nursery stock.

In order to obtain the best results in our efforts to guard the interests of all concerned we must have the coöperation of all parties.

It is the duty of the grower to notify the officers of the department whenever they observe that the sections of the law relating to the certification and transportation of nursery stock have been violated either by nurserymen within or without the state. Upon receiving such information the officers will immediately investigate and correct the irregularity. There is hestitancy on the part of some growers even to-day against planting trees that have been fumigated with hydrocyanic acid gas. There is no reason for this doubt, for it has been conclusively demonstrated not only by this Station, but by many others in the country that nursery trees will stand fumigating without injury with this gas double and three times the recommended strength used by nurserymen in this state, when conducted in the proper manner. If any one desires to see further evidence we will be pleased to send him bulletin No. 105 of this Station in which the subject is thoroughly discussed.

Further, fumigation is the best assurance that the nurserymen can give the orchardists as a preventive in the dissemination of injurious insects. The grower therefore must insist that the nurserymen should, as required by law, fumigate his trees in a proper manner and report to this department failure on the part of nurserymen to comply with same.

SIZE AND GRADE OF NURSERY TREES.

Usually the grade of a nursery tree is determined by its height, straightness of trunk, and caliper at a point three inches from the ground. This rule of size, straightness and trunk caliper, holds for those varieties which are good growers in the nursery, but there are others, and desirable ones too, like Rhode Island Greening, which are crooked growers and make first-class trees even though they are crooked. A first-class tree should be well grown, be healthy and vigorous, have the peculiar characters of the variety (this allows crooked trunks if they result from the natural habit of the tree), be free from insect and disease blemishes, with smooth clean bark and stocky trunk, have the union of cion or bud with stock healed over, and be mature (this means that the green leaves should not be stripped off before they are ready to drop naturally).

Low-headed trees can not of course be graded in height with high headed ones of the same grade, nor can one year old trees compare in all respects with two year olds of the same grade. A general standard for grading is adopted by most nurserymen and this in a measure answers the purpose if the stock is about the same age and character when sold. Now that low headed and one year old trees (besides the peach) are demanded, it might be a good plan to adopt certain measurements for low-headed trees and others for high-headed trees one year old, and other measurements for high-headed trees and low-headed trees two years old, etc.

However, the main point is this—see to it that the nurserymen ship the grade they accept pay for. When writing for prices of trees of different grades, ask them to give measurements of each grade and then refuse to accept any trees not up to those measurements. In other words let the nurseryman establish his grades and make him live up to them.

One nursery firm in Maryland grades its stock as follows:

APPLE, CHERRY AND PEAR.

1st grade— ¾ inch caliper and up—5 to 7 feet high.
2d " ⅝ to ¾ " " " 5 to 6 " "
3d " ½ to ⅝ " " " 4 to 5 " "
4th " —3 to 4 feet high.
5th " —2 to 3 " "

PEACH.

1st grade— $\frac{9}{16}$ inch caliper and up—4 to 6 feet high.
2d " ½ to $\frac{9}{16}$ " " " 3½ to 4½ " "
3d " —3 to 4 feet high.
4th " —2 to 3 " "

It will be noticed that nothing is said regarding age of the apple, cherry and pear stock above, and the measurements all refer to high headed trees. The peach stock is one year old.

CARE OF TREES UPON ARRIVAL.

As soon as shipments arrive the boxes or bales should be opened at once and the trees be heeled in immediately unless they are considerably dried out, in which case they should be buried in damp ground for several days and then be heeled in. To heel in trees in fall for remaining over winter, dig a trench 15 or 18 inches deep running east and west with south side sloping and place the roots in the trench with the tops slanting to the south. Dig away the north bank of the trench and throw the earth over the roots and half way up the trunks and tramp down well. Place another row of trees in the new trench and proceed as before. The roots and part of the trunks must be well covered so they cannot dry out. The object of pointing the tops to the south is to have the branches shade the trunks and thus prevent any injurious action by the winter sun on the trunks as might occur if the tops are pointed in any other direction.

For spring heeling in it does not matter how the tops are placed so long as the roots are kept moist.

It is often the case that when the proper way of heeling in trees is not understood, the roots are only partly covered and they dry out to the extent that the trees make only a weak start, if any, and die during the first season. Naturally, the nurseryman is blamed for sending poor trees although they are first-class and the fault lies entirely with the purchaser.

PLANTING THE TREES.

In digging nursery trees the root system is injured and about seven-eighths or more of it is left in the ground. Since the root system is reduced so much the top must be reduced proportionally to maintain a fair balance between top and root. The roots should be pruned so as to leave only three or four inches of each one. All bruised parts should be pruned off and all cuts should be clean and smooth. The tree is then in shape to be quickly and easily planted for a slight up and down movement of the tree while the earth is being thrown in, will settle the earth around the roots where it should be firmly packed. If the ground is well prepared the holes for the trees need not be very large, but if it is hard or in sod it is well to make them three or even four feet across.

The tops should be pruned leaving spurs with two to four buds each, and the "leader" should be cut off about two and one-half feet from the ground. The more foliage the better on the little trees because leaves increase the circulation and assimilation of the sap and shade the trunks.

CONCLUSION.

In conclusion the writers have endeavored to discuss plainly the various aspects of tree growing from the bud to the orchard field. The suggestions offered embody the results of our experience and observation in the work from conditions as presented in Maryland. There are given parts of the Maryland law which affect both nurseryman and grower and also a summary of the laws of other states giving information as to their respective requirements.

The discussion of the inspection of nurseries and orchards is given for the benefit of all concerned with the hope that there will continue the confidence which should exist among all parties interested.

The officers of the Department solicit the coöperation of all concerned for by this means only can the greatest good result in the promotion of horticulture in Maryland.

There are abundant opportunities for successful orcharding in the state and we should all make every effort to promote the industry and and cause Maryland to be more prominently known as a horticultural state.

THE MARYLAND
Agricultural Experiment Station

BULLETIN No. 131 NOVEMBER, 1908

MISCELLANEOUS TREATMENT FOR SAN JOSÉ SCALE

BY THOMAS B. SYMONS

INTRODUCTION

The control of the San José scale in Maryland has reached the point where spraying for the pest each year is considered by the progressive orchardist as routine work. The home-made lime-sulfur wash is thoroughly established as an effective and cheap remedy for the pest. In addition it has fungicidal properties which usually control the peach leaf curl. The trouble and time involved in making this wash has led orchardists to desire reliable information with regard to the effectiveness in combating the scale, the fungicidal properties, and the general effect on the trees of the various other washes on the market. To this end experiments have been conducted by the Department to test the value of some of these manufactured washes. The results and our recommendations are given under the head of spraying experiments.

The necessity for all nurserymen to fumigate their propagating stock with hydrocyanic acid gas suggested the need of further investigation to ascertain what strength of the gas and duration of exposure would be most certain to kill the scale without injuring the stock. Hence fumigation Experiments I and II. Experiment III gives additional data on the effect of the gas on salable trees.

During the past two or three years nurserymen and orchardists have been discussing the dipping of nursery trees in an insecticide as a substitute for fumigation with hydrocyanic acid gas. This discussion suggested the conducting of experiments to ascertain whether such treatment would be advisable as regards its effect on the tree, and efficiency in preventing the distribution of the San José scale. The discussion following Experiments I, II, and III under dipping Experiments gives the results and our recommendations for this method of treatment.

These experiments on the whole are not as extended as was desired, but the results obtained will indicate what may be expected in actual practice.

The success attending the operation of public sprayers by this department during the past year justifies a reference to this part of the department's work with the hope that it may induce private interests to further engage in this business.

The Department expresses thanks to Messrs. R. P. Beckley of Halfway, Maryland, and Ed. G. Emack of Beltsville, Maryland, for the use of their orchards in conducting the spraying experiments.

Credit is cheerfully given to Mr. A. B. Gahan for able assistance in attending to the details of the dipping experiments in 1906; to Mr. Geo. P. Weldon for his careful work in conducting the experiments in the fumigation of trees and buds and dipping tests in 1906 and 1907, and to Mr. L. M. Peairs for superintending the spraying and dipping experiments conducted during the past season.

SPRAYING EXPERIMENTS.

A number of new patent washes have been put on the market during the past year for the control of the San José scale. In order to answer inquiries regarding them intelligently it was necessary to test them in actual practice. There is no doubt that the activity of these manufacturers in placing the different mixtures on the market has in the majority of cases had a good effect in promoting general spraying operations. Growers should be careful, however, about using any of the new mixtures before they have been thoroughly tested.

While possessing a spirit of coöperation with all in the endeavor to secure the best insecticide for any given pest we deem it our duty to the public to give actual results obtained in our tests and to speak frankly in giving our recommendations deduced from these experiments as well as from general observations throughout the state.

All the spray solutions were applied in the apple orchard of Mr. R. P. Beckley of Halfway. The orchard consisted of about 400 ten year old trees rather small for their age, all more or less badly infested with scale. The trees were sprayed March 27 and April 3, 1908. A strong wind on the first day interfered with the spraying to some extent, although on the whole the sprays were applied in a very satisfactory manner.

A further experiment with the concentrated lime-sulfur wash was conducted in the peach orchard of Mr. E. G. Emack at Beltsville, Maryland. The orchard contained about 100 trees, four years old.

No attempt was made to conduct these tests upon a commercial basis, for in this case, as with all insecticides, the point first to be determined is the degree of efficiency of any wash when applied as thoroughly as possible. If a wash is shown to be efficient when thoroughly applied, the success or failure attending its use on a commercial scale will depend upon the ease of application and the quality of the work done.

EXPERIMENT I.

HOME-MADE LIME-SULFUR (20 – 15-50).

The standard lime-sulfur wash was applied on twenty-nine trees in the orchard. This was applied primarily for comparison with the other washes. On account of the wind, it was more difficult to spray thoroughly at the time of applying this wash than any other in the experiment. The results were therefore not quite so good as have been secured in former tests. The treatment, however, can be considered satisfactory, as only a small amount of scale could be found at the final examination of the trees in this test.

EXPERIMENT II.

NIAGARA BRAND CONCENTRATED LIME-SULFUR (APPLIED 1 to 12 and 1 to 9).

This is a new wash placed on the market by the Niagara Spray Company, Rochester, New York. As its name indicates it is a concentrated lime-sulfur solution. Twenty-six trees were sprayed with the solution. It mixed readily with water and at the strength of 1 to 9 gave very good results. Some differences in favor of the stronger solution was noted.

EXPERIMENT III.

ORCHARD BRAND LIME-SULFUR (APPLIED 1 TO 12 AND 1 TO 9).

This is also a new spray placed on the market by the Thomsen Chemical Company of Baltimore, Maryland. Thirty-three apple and about one hundred peach trees were treated with the preparation.

Like the above it readily mixed with water and proved very effective, the stronger solution giving better results.

EXPERIMENT IV.

REX LIME-SULFUR (APPLIED 1 TO 12 AND 1 TO 9)

This concentrated wash has been on the western markets for two years. It is sold by the Rex Company of Omaha, Nebraska. The solution was employed in our tests of 1907 and gave then, as on this occasion, very good results. A favorable difference was noted in the use of the stronger solution. Of all the concentrated lime-sulfur washes this seemed to remain on the trees the longest period and this no doubt accounts for its apparent slightly greater effectiveness.

EXPERIMENT V.

SAN-U-ZAY (APPLIED 1 TO 15 AND 1 TO 20).

This oil solution was brought to our attention by the T. S. Southwick Company of Rochester, New York, who desired that it be tested on San José scale at the strengths of 1 to 10, 1 to 15 and 1 to 20. On account of lack of material we were able to apply it only at the two latter strengths. The solution is now being sold by the F. G. Street Company of Rochester, New York. The oil being of a heavy grade, some difficulty was experienced in getting the solution to mix with water as readily as other miscible oils. Also it showed a tendency to coagulate in the spray barrel when mixed with very cold water. No reason can be given for this action as the company claims it to blend instantaneously with any kind of water. Twenty-two trees were sprayed with the two strengths of the mixture. While there is a little difference in the final results of the two strengths, the treatment proved ineffective, and from these tests cannot be considered a satisfactory remedy for the pest at the strengths indicated.

EXPERIMENT VI.

TARGET BRAND SCALE EMULSION (APPLIED 1 TO 15 AND 1 TO 20).

This solution, which has been on the market for some time, was again included in our tests. It is sold by the Horticultural Distributing Company of Martinsburg, West Virginia. Thirty-three trees were sprayed with two strengths of the solution which is easy to apply and readily mixes with water.

The results from the 1 to 15 solution were satisfactory, the trees sprayed showing only a small amount of scale at final examination.

EXPERIMENT VII.

ORCHARD BRAND SOLUBLE OIL (APPLIED 1 TO 15 AND 1 TO 20).

This soluble oil is sold by the Thomsen Chemical Company of Baltimore, Maryland. The solution readily mixes with water and is easy to apply. Thirty-five trees were sprayed with the two strengths of solution.

The results from the 1 to 15 solution were very satisfactory, the trees treated showing only slight infestation at the end of the season.

EXPERIMENT VIII.

AVENARIUS CARBOLINEUM (APPLIED 1 TO 15 AND 1 TO 20).

This material has been sold for many years by the Carbolineum Wood Preserving Company as a wood preservative and is no doubt a satisfactory solution for that purpose.

From the fact that some parties had been able to secure a good emulsion by the use of this solution with soap, etc., the Company desired to have this emulsion tested to ascertain if it had insecticidal properties, especially in controlling the San José scale. We attempted to carry out their directions and made a fair emulsion, spraying it on twenty-three trees in the orchard. The results of the treatment were very unsatisfactory. There was considerable difference between the two strengths used, but even the stronger wash cannot be considered as an effective treatment.

CHECK PLATS.

Twenty-two trees were reserved in the orchard as checks on the experiments. The scale bred on these trees throughout the summer and they are now in very bad condition.

SUMMARY.

From these tests it appears that all the stronger solutions employed with the exception of San-U-Zay and Avenarius Carbolineum gave good results. These two solutions, even at 1 to 15 strength, did not kill enough scale to justify their use. It may be stated, however, that on account of the limited experiment these results cannot be considered as conclusive.

TABULATED SUMMARY OF RESULTS.

Insecticide used.	Strength.	No. of trees sprayed	Condition of trees before spraying.	Final results in killing scale Sept. 25, 1908.
Lime-sulfur	Regular formula. lime 20 lbs. sulfur 15lbs	29	Badly infested	Very good.
Niagara brand Con. lime-sul	1 to 12	16	Badly infested	Good.
Niagara brand Con. lime-sul.	1 to 9	10	Badly infested	Very good.
Orchard brand Con. lime-sul.	1 to 12	17	Badly infested	Very good.
Orchard brand Con. lime-sul.	1 to 9	16	Badly infested	Very good.
Rex lime-sulfur	1 to 12	13	Moderately infested	Very good.
Rex lime-sulfur	1 to 9	14	Moderately infested	Excellent.
San-U-Zay	1 to 20	10	Badly infested	Poor.
San-U-Zay	1 to 15	12	Badly infested	Very poor.
Orchard brand soluble oil	1 to 20	16	Badly infested	Good.
Orchard brand soluble oil	1 to 15	19	Badly infested	Very good.
Target brand	1 to 20	14	Moderately infested	Fair.
Target brand	1 to 15	16	Moderately infested	Good.
Avenarius carbolineum	1 to 20	12	Badly infested	Very poor.
Avenarius carbolineum	1 to 15	11	Badly infested	Very poor.
Check		20	Moderately infested	Very scaly.

RECOMMENDATIONS.

Observations of sprayed orchards throughout the State during the past season justify a further discussion of the remedies for the scale. These remedies may generally be divided into two classes: viz, miscible or soluble oils and lime-sulfur compounds.

MISCIBLE OILS.

Since the introduction of these preparations on the market this department has been very conservative in recommending their use. In our experience they have seldom proved satisfactory when used at the strength recommended by the manufacturer and at greater strengths there has been a possibility of injury to trees. While there has been no apparent injury to trees from any of these washes in our experiments, yet serious injury has been reported from the use of two of them the past season on peach trees. The cases of injury were investigated thoroughly and only the character of the parties and the special care taken in making the applications justify this allusion to the matter as a warning to the growers to be on their guard. Injury occurred on peach trees only, but it was so pronounced that care should be exercised in employing such treatment for other kinds of trees. While no doubt these spray mixtures will be more satisfactory on apple than on peach trees, fruit growers should investigate the character of any one of them before using either.

LIME-SULFUR COMPOUNDS.

Manufacturers appreciating the demand for a lime-sulfur wash which can be sold ready for use have placed on the market several brands of concentrated lime-sulfur compounds. Three brands of this solution were included in our experiments this year. The Rex solution was also tested last year. A quantity of the Orchard brand solution has been used by growers in different parts of the State during the past season.

The results of our tests with these solutions on apple and peach were very satisfactory. Observations indicated equally as good results in controlling scale where the concentrated lime-sulfur solution was used by growers. Among the latter, however, there is a difference of opinion as regards the ability of these concentrated solutions to control the peach leaf curl, and their general adoption seems to hang on their fungicidal properties. All that can be said in regard to this aspect of the treatment, is that further experimentation is necessary to clear the question. In our experiment, when the concentrated solution was sprayed on over one hundred trees no curl developed. Also we have a report from a responsible orchardist who sprayed 1256 peach trees seven years old, 700 of which were of the Elberta variety, which generally is subject to injury from leaf curl, and he reports no injury from this disease in spite of the fact that the curl was very bad in his orchard last year. Further this same grower had 100 old Elberta trees in a separate block, 30 of which were sprayed with the solution and these 30 were practically free from curl while the remaining 70 were severely injured by the disease. This would indicate a fair test and the results go to show that the solution will control the leaf curl fungus.

However, considerable injury was observed in another orchard by the leaf curl on trees that had been sprayed with the same solution.

Finally, while the home-made lime-sulfur is considered to be the very best spray solution for the control of the San José scale where circumstances are convenient for its use, yet if it is desired to use a more easily prepared wash, the concentrated lime-sulfur solutions used in our tests seem to offer a favorable substitute for general use, although they are somewhat more expensive.

These solutions at their present strength should be applied at the rate of one part solution to nine parts of water and the addition of a little free slaked lime by the manufacturer or orchardist will be an advantage to the wash.

The method of making the home-made lime-sulfur and also general instructions in spraying and spray pumps have been given so frequently in previous bulletins of this experiment station, which can be had for the asking, that it is not thought necessary to repeat them here.

FUMIGATION EXPERIMENTS.

The desire to obtain further information in regard to the fumigation of propagating stock with hydrocyanic acid gas prompted us to conduct a series of tests with young peach buds to observe the effect upon the vitality of the bud as well as upon the scale. These experiments were conducted in two nurseries of the State under conditions as nearly normal as possible.

In the following tables will be shown the different experiments employed, stating the strengths of cyanide used, duration of exposures and the final results.

EXPERIMENT I.

Showing results of fumigating 1310 peach buds with hydrocyanic acid gas at different exposures. Experiment conducted September 7, 1906.

Test No.	No. of buds.	Variety.	Strength of gas per cu. ft.	Duration of exposure.	Buds Alive Oct. 13, 1906.		Buds Alive Aug. 30. 1907.	
					No.	Per cent.	No.	Per c.
			grams.					
1.	100	Early Crawford	0.40 and 0.50	30 min.	100	100	73	73
	100	Late Crawford	0.40 and 0.50	30 min.	100	100	65	65
	100	Reeves Favorite	0.40 and 0.50	30 min.	99	99	57	57
	100	Elberta	0.40 and 0.50	30 min.	100	100	63	63
	105	Beers Smock	0.40 and 0.50	30 min.	105	100	58	55.2
2.	160	Late Crawford	0.40 and 0.50	60 min.	159	99.3	87	54.3
	160	Early Crawford	0.40 and 0.50	60 min.	159	99.3	90	56.2
	160	Reeves Favorite	0.40 and 0.50	60 min.	152	95	67	41.8
	160	Elberta	0.40 and 0.50	60 min.	150	93.7	87	54.3
	165	Beers Smock	0.40 and 0.50	60 min.	164	98.7	98	59.3
Check	approximately 750	Elberta	Not fumigated				157	20.9

CONCLUSIONS.

1. It is seen from the above that the excessive amount of 0.50 grams of cyanide per cu. ft. (practically 2 ounces of cyanide to the 100 cu. ft.) will not injure peach buds under ordinary conditions of fumigation, since the average proportion of unfumigated buds which live is only 60 to 65 per cent.

2. That practically no difference was noted in the vitality of the buds exposed in the gas at the above strengths for one hour and those

exposed for half an hour at the first examination October 13, 1906, over a month having elapsed from the time they were budded. The practically 10 per cent difference at the final examination can hardly be attributed to the gas when the check is taken into consideration.

3. That the large per cent of living fumigated buds as compared with the check row is due to other influences than fumigation.

EXPERIMENT I-A.

Showing results of fumigating 2647 peach buds with different strengths of hydrocyanic acid gas at different exposures. Experiment conducted September 1, 1906.

Test No.	No. of buds.	Variety.	Strength of gas per cu. ft.	Duration of exposure.	Buds Alive Oct. 9, 1908.		Condition Fall of 1907
					No.	Per ct.	
1.	321	Elberta	0.15 grams	30 min.	137	43.0	The very poor stand due to excessive wet weather in checks as well as throughout the field caused the abandonment of further observations.
	178	Champion			128	71.9	
2.	281	Elberta	0.15 grams	60 min.	161	57.3	
	142	Champion			105	73.8	
3.	188	Elberta	0.18 grams	30 min.	76	40.4	
	104	Champion			48	46.0	
4.	222	Elberta	0.18 grams	60 min.	93	41.9	
	134	Champion			63	47.0	
5.	217	Elberta	0.20 grams	30 min.	81	37.3	
	128	Champion			7	5.5	
6.	231	Elberta	0.20 grams	60 min.	101	43.7	
	168	Champion			52	31.0	
7.	200	Elberta	0.25 grams	30 min.	59	29.0	
	133	Champion			76	57.1	

CONCLUSIONS.

Even under the adverse conditions which befell this block of buds it may be seen that there is no difference in the results from 30 minute, and from one hour exposures, in fact, in every case there were more buds alive from those that were exposed the longer period. Further, no consideration can be taken of the low per cent of living trees from the highest strength of gas as a decidedly smaller number of trees lived in a lower strength of gas, viz, No. 6 which has been the normal strength recommended.

EXPERIMENT II.

Showing results of fumigating 270 peach buds with various strengths of hydrocyanic acid gas, September 7, 1906. All buds were known to be infested with San José scale.

Test No.	No. of buds.	Variety.	Strength of gas per cu. ft.	Duration of exposure.	Buds Alive Oct. 13, 1906.		Buds Alive Aug. 30, 1907.		No. of trees infested Aug. 30, 1907.
					No.	Per cent.	No.	Per cent.	
1.	140	Elberta	0.285 grams 0.35 grams 0.40 grams	30 min.	140	100	54	38.5	None
2.	135	Heaths freestone	0.285 grams 0.35 grams 0.40 grams	30 min.	135	100	52	30	None

EXPERIMENT II–A.

Showing results of fumigating 624 peach buds with various strengths of hydrocyanic acid gas, August 27, 1907. All buds except check infested with San José scale.

Test No.	No. of buds.	Variety.	Strength of gas per cu. ft.	Duration of exposure.	Buds Alive Sept. 10, 1908.		No. trees infested with scale.
					No.	Per cent.	
1.	167	Late Crawford	0.18 grams	45 min.	90	53.8	None.
2.	240	Late Crawford	0.20 grams	45 min.	137	57.	None.
3.	217	Late Crawford	0.30 grams	45 min.	103	47.4	None.
Check	136	Late Crawford	Not fumigated		71	52.2	

CONCLUSIONS.

1. All the strengths of gas employed were successful in killing the scale.

2. The fumigated buds gave a higher per cent of live trees at final examination than the check, showing that fumigation at the highest strength did not injure the buds in any way.

EXPERIMENT III.

Showing the results of fumigating 500 nursery trees badly infested with San José scale with hydrocyanic acid gas December 4th, 1906. Twenty peach and thirty apple trees were used in each test.

Test No.	Strength of gas per cu. ft.	Duration of exposure.	Condition of trees, Sept. 1907.
1.	0.15 grams	30 min.	Trees showed abundance of living scale.
2.	0.15 grams	60 min.	Trees showed no live scale.
3.	0.20 grams	30 min.	Trees showed few live scale.
4.	0.20 grams	60 min.	No sign of scale.
5.	0.30 grams	30 min.	Live scale found on six trees. All trees vigorous.
6.	0.30 grams	60 min.	No sign of scale found. All trees vigorous.
7.	0.40 grams	30 min.	No sign of scale found. All trees vigorous.
8.	0.40 grams	60 min.	No sign of scale. All trees vigorous.
9.	0.50 grams	30 min.	No sign of scale. All trees vigorous.
10.	0.50 grams	60 min.	No sign of scale. All trees vigorous.

CONCLUSIONS.

1. That fumigation at 0.50 grams cyanide for one hour did not injure trees.
2. That 0.30 grams with 30 minutes exposure is hardly sufficient for fumigating trees known to be infested with scale, and that with this strength a 45 minute exposure should be made in order that the gas may be considered a fairly sure preventive.

EXPERIMENT III–A.

Showing results with 80 nursery trees infested with San José scale fumigated November 2, 1906, with different strengths of hydrocyanic acid gas at different exposures. Ten apple trees were used in each test.

Test No.	Strength of gas per cu. ft.	Duration of exposure.	Condition of trees, July 11, 1907.
1.	0.15 grams	30 min.	Three dead. Live scale found on three trees.
2.	0.15 grams	60 min.	One tree dead. No live scale.
3.	0.20 grams	30 min.	Two trees dead. Scale on one tree.
4.	0.20 grams	60 min.	Four trees dead. No live scale.
5.	0.28 grams	30 min.	Trees all dead.
6.	0.28 grams	60 min.	One tree dead. No live scale.
7.	0.56 grams	30 min.	Six trees dead. No live scale.
8.	0.56 grams	60 min.	Three trees dead. No live scale.

NOTE.—The trees in this experiment were fumigated at the nursery and shipped to College Park. They were delayed on the road and accordingly were not in the best condition for planting upon arrival. For this reason no accurate conclusions can be drawn, but it is seen that no more trees are dead in the test with the highest strength of gas and the longest duration of exposure than in the weakest gas with shortest duration of exposure.

SUMMARY OF FUMIGATION EXPERIMENTS.

The results of these experiments go to show the wisdom of fumigating all buds for propagating purposes with hydrocyanic acid gas by all nurserymen, and that inasmuch as the San José scale may at any time be introduced into a nursery, fumigation with this gas is the best guarantee that the nurseryman can employ against future losses from this pest. Moreover, fumigation with this gas when properly conducted is the best guarantee that the nurseryman can give his patrons in preventing the distribution of the San José scale on nursery stock.

The tests in fumigating buds demonstrate that a much higher strength of gas and longer exposure than is ordinarily recommended, viz, 0.16 to 0.20 grams per cu. ft. can be employed without endangering the vitality of the buds, and that the exposure to the gas even at normal recommended strength for buds should be at least 45 minutes.

In fumigating nursery trees at the normal recommended strength, viz: 1 ounce of cyanide to 100 cu. ft. the duration of exposure should be one hour, and if less time is desired the strength of the gas may be increased with perfect safety to the trees, and insure as far as possible the killing of any scale that may be present.

EXPERIMENTS IN DIPPING NURSERY TREES.

From time to time during the past two or three years there have been inquiries as to the effectiveness and practicability of dipping nursery trees in lime-sulfur or other spray mixtures as a preventive against the dissemination of San José scale either for the purpose of substituting such treatment for fumigation with hydrocyanic acid gas at the nursery or giving such additional treatment by the orchardist before planting as a further means of killing any scale that may have escaped previous treatment. Some orchardists would prefer dipping in place of fumigation with hydrocyanic acid gas on account of their prejudice against fumigation. But in the light of extended investigations conducted over the country, there is no reason for this prejudice in fearing injury from fumigation with this gas when properly conducted.

The tests have not been as extended as was desired on account of various circumstances, but these results will add to the limited amount of work published on the subject.

EXPERIMENT I.

During March, 1906, 240 dormant nursery trees, 160 apple and 80 peach trees were dipped instantaneously in the lime-sulfur-salt wash formula (20 lime, 15 sulfur and 10 salt to 50 gallons of water, boiled for one hour with steam.)

1. Forty apple and twenty peach were dipped, roots and stems, in the mixture at a temperature of about 170 degrees Fahrenheit.

RESULTS:—At final examination September, 1906, all trees in this lot were dead. Only two had started to grow.

2. Forty apple and twenty peach were dipped, stems only, in the mixture at 170 degrees Fahrenheit.

RESULTS:—The final examination in September showed that all the stems or tops had been scalded and but 23 apple and 16 peach had started at or near the top of the ground and were growing.

3. Forty apple and twenty peach were dipped, roots and stems, in the mixture at a temperature of about 120 degrees Fahrenheit.

RESULTS:—At final examination in September, only 10 apple and 3 peach were alive.

4. Forty apple and twenty peach were dipped, stems only, in the mixture at a temperature of 120 degrees Fahrenheit.

RESULTS:—At final examination in September 30 apple and 19 peach were alive and doing well.

EXPERIMENT II.

On the 27th of April, 1907, sixty-nine apple and peach trees infested with San José scale were dipped instantaneously, tops only, in the home-made lime-sulfur wash at a temperature of 122 degrees Fahrenheit. Also about 100 well grown plants of California privet were dipped, tops only, in the same solution. All stock was planted out the same day as dipped.

RESULTS:—Examination November 29, 1907, showed no injury apparent, as all had grown well. No scale could be found on any of the plants.

EXPERIMENT III.

Showing results of dipping instantaneously salable nursery trees, peach and apple in various spray solutions November 29, 1907. Carolina Red June and Horse varieties of apple, and Bokahra, Belle of Georgia and New Prolific varieties of peach were used in the test.

Kind of trees.	No.	Condition of trees.	Parts dipped.	Solution.	Condition of trees June 5, 1908.	Condition of trees October 15, 1908.
Peach 2 Apple 3	5	Scaly	Root and Stem	Lime-sulfur 100° F.	Good, no scale present	Good, no scale present
Peach	15	Scaly	Stem only	Lime-sulfur	Good, no scale present	Good, no scale present
Peach 7 Apple 6	13	Clean	Stem only	Lime-sulfur	Good, no scale present	Good, no scale present
Peach 2 Apple 3	5	Clean	Root and stem	Scalecide 1–15	Good, no scale present	Good, no scale present
Peach 5	5	Scaly	Root and stem	Scalecide 1–15	Good, no scale present	Good, no scale present
Peach	15	Scaly	Stem only	Scalecide 1–15	Good, no scale present	Good, no scale present

EXPERIMENT III—Continued.

Kind of trees.	No.	Condition of trees.	Parts dipped.	Solution.	Condition of trees June 5, 1908.	Condition of trees Oct. 15, 1908.
Peach 7 Apple 8	15	Clean	Stem only	Scalecide 1–15	Good, no scale present	Good, no scale present
Apple 2 Peach 3	5	Clean	Root and stem	Target brand 1–15	Good, no scale present	Good, no scale present
Peach 5	5	Scaly	Root and stem	Target brand "	Good, no scale present	Good, no scale present
Peach	15	Scaly	Stem only	Target brand "	Good, no scale present	Good, no scale present
Peach 7 Apple 8	15	Clean	Stem only	Target brand "	Good, no scale present	Good, no scale present
Peach 3 Apple 2	5	Clean	Root and stem	Soluble oil 1–15	Good, no scale present	Good, no scale present
Peach 5	5	Scaly	Root and stem	Soluble-oil 1–15	Good, no scale present	Good, no scale present
Peach	15	Scaly	Stem only	Soluble-oil 1–15	Good, no scale present	Good, no scale present
Peach 7 Apple 8	15	Clean	Stem only	Soluble-oil 1–15	Good, no scale present	Good, no scale present
Apple 3 Peach 2	5	Clean	Root and stem	Kilo-scale 1–15	Good, no scale present	Good, no scale present
Peach 5	5	Scaly	Root and stem	Kilo-scale 1–15	Good, no scale present	Good, no scale present
Peach	15	Scaly	Stem only	Kilo-scale 1–51	Good, no scale present	Good, no scale present
Peach 8 Apple 7	15	Clean	Stem only	Kilo-scale 1–15	Good, no scale present	Good, no scale present

CONCLUSIONS.

1. No trees in this test, either those dipped stem only, or root and stem seemed to be injured in any way by any of the solutions, as at this date (October 16, 1908) all trees are in good shape.

2. Careful examination October 16, 1908, of all trees infested with San José scale before dipping shows that all the solutions in this test were effective in killing the scale or preventing its breeding.

EXPERIMENT IV.

Showing results of dipping instantaneously salable nursery trees, peach and apple in various spray solutions April 14 and 16, 1908. Carolina Red, June and Horse varieties of apple and Belle of Georgia and Late Crawford varieties of peach were used in the test.

Kind of trees.	No.	Condition of trees.	Parts dipped.	Solution.	Condition of trees June 5, 1908.	Condition of trees Oct. 15, 1908.
Peach 5 Apple 5	10	Clean	Stem only	Lime-sulfur 100° F. 20–15–50	All alive and doing well	No scale present
Peach 4 Apple 4	8	Clean	Root and stem	Lime-sulfur	All vigorous	No scale present
Peach	10	Scaly	Stem only	Lime-sulfur	1 tree dead	No scale present
Peach	10	Scaly	Root and stem	Lime-sulfur	2 trees dead	No scale present
Apple 5 Peach 5	10	Clean	Stem only	Target brand 1–15	2 peach, 1 apple dead; tops of live peach injured	No scale present
Apple 4 Peach 4	8	Clean	Root and stem	Target brand 1–15	1 apple, 1 peach dead; tops of live peach injured	No scale present
Peach 10	10	Scaly	Root and stem	Target brand 1–15	2 trees dead; tops of others very bad	No scale present
Peach	10	Scaly	Stem only	Target brand 1–15	1 tree dead; others serious injured	No scale present
Apple 5 Peach 5	10	Clean	Stem only	Soluble-oil 1–15	1 peach tree dead	No scale present
Apple 4 Peach 4	8	Clean	Root and stem	Soluble-oil 1–15	Condition good	No scale present
Peach	10	Scaly	Root and stem	Soluble-oil 1–15	3 trees with tops injured	No scale. present
Peach 10	10	Scaly	Stem only	Soluble-oil 1–15	4 trees with tops injured	No scale present

EXPERIMENT IV—Continued.

Kind of trees.	No.	Condition of trees.	Parts dipped.	Solution.	Condition of trees June 5, 1908.	Condition of trees Oct. 15, 1908.
Apple 4 Peach 4	8	Clean	Stem only	Scalecide 1–15	Tops of all peach and 1 apple badly injured	No scale present
Peach 5 Peach 5	10	Clean	Root and stem	Scalecide 1–15	1 peach dead; tops injured	No scale present
Peach	15	Scaly	Stem only	Scalecide 1–15	1 top dead; others good	No scale present
Peach 10	10	Scaly	Root and stem	Scalecide 1–15	5 tops badly injured	No scale present
Apple 5 Peach 5	10	Clean	Stem only	San-U-Zay 1–15	All dead but two apple	No scale present
Apple 4 Peach 4	8	Clean	Root and stem	San-U-Zay 1–15	All practically dead.	No scale present
Peach 10	10	Scaly	Stem only	San-U-Zay 1–15	All dead	
Peach 5	5	Scaly	Root and Stem	San-U-Zay 1–15	All dead	
Apple 6 Peach 6	12	Check	Not dipped		All alive and thrifty	

CONCLUSIONS.

1. The fact that most of the trees in this experiment were just beginning to leaf when they were dipped, is no doubt the cause for the injury to the tops from the various solutions. However, those used in the tests where no injury is shown were similar to those that were injured. This goes to show that trees should be dipped only when in a completely dormant condition.

2. As in the previous test no live scale could be found at the final examination, October 15, 1908, on the trees that were infested before treatment.

SUMMARY OF DIPPING EXPERIMENTS.

A summary of these experiments shows that dipping dormant nursery trees in the lime-sulfur wash, either stems and roots or stems alone, at a temperature of 172 degrees Fahrenheit, may be expected to be attended by severe injury to the trees and a much lower temperature would be desirable if the effect upon the health of the trees alone could be considered. In the first experiment considerable difference is noted in dipping roots and stems and stems alone in the solution at 172 degrees Fahrenheit. In the succeeding experiments practically no difference could be detected between those immersed stems and roots or stems alone in the lime-sulfur solution at 100 degrees Fahrenheit or other solutions employed, with possibly the exception of some miscible oils. We believe, however, the dipping of the roots of trees in any of these solutions to be rather a questionable procedure and not a safe treatment for the trees.

The results as indicated in experiments two, three and four go to show that dormant nursery trees may be dipped instantaneously stems or tops only in the lime-sulfur wash at or below the temperature of 100 degrees Fahrenheit and in the various miscible oils employed in our tests without apparent injury resulting to the trees. They also show that only strictly dormant nursery stock should be dipped in any of the solutions used.

These experiments further indicate that such treatment may be considered effective in combating the San José scale, as in all the tests where infested trees were dipped no live scale could be found on the trees at the final examination. However, the published results of other experimenters and the limited number of infested trees included in these tests, lead us to consider that these results may be inconclusive.

These varying results go to show that further experimentation is necessary in order to establish what may be expected from such treatment before its adoption for general use becomes desirable.

PRACTICABILITY OF DIPPING TREES.

Even if the dipping of salable trees in the dormant state should prove a safe treatment in preventing the distribution of San José scale, and though subsequent experimentation should thoroughly establish such treatment to be unattended by injury to trees, the practicability of its use by nurserymen as a substitute for fumigation is questionable. Obviously the dipping of all trees before shipment would be a more laborious task than fumigation, in addition to the unfavorable condition of the trees for handling after such treatment.

The question of expense should also be considered, for there is no doubt that such treatment would be an added expense to the nurserymen. Moreover, no matter what further experimentation may develop, there would always be the possibility of injury to trees when subjected to such treatment by careless laborers. While this latter objection is equally true with fumigation with hydrocyanic acid gas the nurserymen have long realized the importance of placing the fumigation of stock in the hands of one responsible person. Nor can we point out any advantage from dipping nursery stock by the orchardist before planting inasmuch as the law requires the fumigation with hydrocyanic acid gas of all deciduous stock before shipment, and as this treatment is the surest guarantee that the nurseryman can give the orchardist that the scale or other pest, that by chance may be present, is killed, there is no need of subjecting the trees to other treatment before planting. Moreover, when trees arrive at their destination in spring they often have started to leaf or at least the buds have begun to swell and open and as we have seen, dipping trees in any solution when they are in this condition is liable to be attended with injury.

The expense and especially the inconvenience of handling nursery stock after dipping would be as troublesome to the orchardist as it would be to the nurseryman. In addition subjecting the trees to this unnecessary treatment would afford another opportunity for undue exposure of the roots of the trees which is no doubt a cause of the death of a large per cent of the trees that fail to grow.

Finally, we do not recommend dipping salable nursery trees in any solution until further experimentation shall have been conducted in order to more thoroughly establish the effect of such treatment upon the trees and scale, and even if such treatment should ultimately prove efficacious we do not believe its substitution for fumigation with hydrocyanic acid gas desirable under present conditions.

PUBLIC SPRAYERS.

In Bulletin 123 of this experiment station attention was directed to the great need of public spraying outfits in various parts of the state, especially in localities where fruit trees are grown by the farmers for home use only and around our cities, towns and villages where a few trees only are grown by suburbanites for the same purpose. Among this class of people there is not sufficient interest at stake ordinarily to justify their procuring spraying apparatus properly to treat a half dozen or so trees, but they are usually sufficiently eager to have their trees healthful and will willingly employ a public spraying outfit to treat such trees effectively, especially where the trees are infested with San José scale. Indeed it may be stated that the prevalence of this pest on fruit trees in our towns and villages and the desire of furnishing a means of control was the principal incentive to inaugurate this work.

In order to demonstrate the field for a successful business to the end of inducing private parties to take up the work, this Department established ten public spraying outfits in different parts of the State during the past season. Each outfit consisted of a small boiler and barrel spray pump and accessories. A responsible man was secured to superintend each outfit. The spraying was conducted on a basis of cost of operation and not with any desire to make a profit for the Department. Fortunately, the practical operation of these spraying outfits was attended with success in each locality where established. In nearly all the districts there was more work than the outfits could accomplish prior to the opening of buds which prevented spraying with a wash for dormant trees only. One rig, however, was operated late in the spring, a spray being applied to control the codling moth.

As a result of this so-called demonstration work arrangements we understand, have been perfected, whereby private parties will conduct public sprayers in at least three different parts of the State this coming fall and spring and it is hoped others will realize the opportunity for remunerative employment from the proper operation of such a business.

This department has received many favorable comments from persons whose trees and shrubs have been benefited by the spraying and also requests from many persons for the location of public sprayers in their respective localities. Our limited funds will permit of only a certain amount of such extension or demonstrative work but we stand ready to aid all parties and localities in so far as our means will allow. It is firmly believed that such demonstrative work is of paramount importance in the dissemination of information that will lead to a better understanding and a more vigorous control of our injurious insect pests.

THE MARYLAND
Agricultural Experiment Station

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IRISH POTATO INVESTIGATIONS

BY C. P. CLOSE AND T. H. WHITE

INTRODUCTION

The work reported on in this Bulletin was started in 1901. Some of the experiments point so consistently in one direction that the results may be considered conclusive. Others will be continued with the hope that something further may be learned.

The cultural tests which were conducted during the years 1901 to 1904, inclusive, were planned by W. T. L. Taliaferro, professor of agriculture. The details were looked after and the records kept by E. O. Garner, farm superintendent, from whose books the results and averages have been worked out.

The collection of varieties was secured from abroad, and from other states, in the spring of 1905, by W. N. Hutt, who was then professor of horticulture, for the purpose of selection and cross breeding, which was to have been conducted by S. B. Shaw. Mr. Shaw resigned before much had been done along this line and the experiment work from that time has been in charge of Thos. H. White, who has observed and investigated the various lines of work reported herein.

THE PURPOSE OF THE EXPERIMENTS

1. Cultural experiments to ascertain whether shallow, medium, or deep culture, at intervals of five, ten or fifteen days, would produce the best crop.
2. To determine the relative yields from seed grown in Maryland, in Maine, and as "second crop" in Virginia.

3. To determine if cold storage seed with sprouting retarded, is better than ordinary storage with seed sprouted.

4. To notice what would be the difference in yield between crops resulting from tubers having very weak sprouts, and tubers of the same lot having strong sprouts.

5. To test the value of seed potatoes grown early and harvested in summer, versus the fall grown crop.

6. To note the difference in yield from eyes taken from the base, or stem end, and those from the terminal, or seed end, of tubers grown in Maine, and the summer grown seed of Maryland.

7. To test the productiveness of fall harvested tubers from the largest, or egg-size, down to the smallest, or marble-size.

8. To test varieties of American, French and German origin.

CULTURAL EXPERIMENTS

This was conducted four seasons and the plan was to divide a suitable piece of land into three sections. These sections were cultivated shallow, medium, and deep. All sections were treated exactly alike until the first cultivation when each section was sub-divided for the five, ten and fifteen day interval cultivations.

This altogether made nine plots which were treated as follows:

Plot 1. Shallow cultivation every five days.
Plot 2. Shallow cultivation every ten days.
Plot 3. Shallow cultivation every fifteen days.
Plot 4. Medium deep cultivation every five days.
Plot 5. Medium deep cultivation every ten days.
Plot 6. Medium deep cultivation every fifteen days.
Plot 7. Deep cultivation every five days.
Plot 8. Deep Cultivation every ten days.
Plot 9. Deep cultivation every fifteen days.

Rainy weather occasionally delayed cultivation a day or two.

The shallow cultivation was done with a Keystone weeder which simply scratched the surface.

The medium deep cultivation was done by a Planet Junior fourteen toothed harrow cultivator, with a wheel in front and a leveling or smoothing device at the back. The depth was regulated as nearly as possible to two and one-half inches.

The deep cultivation was done with an "Iron Age" five shovel cultivator regulated to a depth of five inches.

The number of cultivations was six, four, and two for the five day, ten day, and fifteen day interval cultivations respectively.

Table I on page 154 shows the yield in bushels per acre of primes and culls from shallow, medium and deep cultivation, at five, ten and fifteen day intervals. Primes include all merchantable potatoes.

From table I the following sets of figures are obtained to show the average of yields as affected by depth of cultivation, disregarding the number of times cultivated.

SURFACE		MEDIUM DEEP		DEEP	
Bu. Primes	Bu. Culls	Bu. Primes	Bu. Culls	Bu. Primes	Bu. Culls
127.3	30.0	137.9	30.3	141.6	28.2

And also the average of yields as affected by frequency of cultivation, disregarding depth.

FIVE DAYS		TEN DAYS		FIFTEEN DAYS	
Bu. Primes	Bu. Culls	Bu. Primes	Bu. Culls	Bu. Primes	Bu. Culls
126.5	27.4	132.4	27.6	147.5	33.2

The above figures seem to clearly indicate that the deep and infrequent cultivation was most profitable, there being a difference of more than fourteen bushels per acre in favor of the deep over the shallow cultivation, and of twenty-one bushels in favor of infrequent working. It would seem, therefore, that the practice of farmers who usually cultivate with such tools and at such times as will keep the crop free from weeds, is about all that is necessary to produce a good crop under the conditions prevailing here. The result may have been different if the same experiment had been conducted in the arid West. It is only at rare intervals that the rainfall in Maryland is so slight that it is practicable or necessary to work for a "dust mulch." What is really important is to destroy the weeds and stir the soil fairly deep to aërate, and at the same time dry it, and make it loose and friable.

YIELDS FROM SEED GROWN IN MAINE, MARYLAND AND VIRGINIA

It is the practice of specialists in potatoes in this state not to depend upon home grown summer harvested seed for the next crop. They have found that while the tubers might be at least as numerous, they

TABLE I

Shows yield of primes and culls in bushels per acre on the nine plots for four years, and the average yield per acre of each plot

SEASON	PLOT 1		PLOT 2		PLOT 3		PLOT 4		PLOT 5		PLOT 6		PLOT 7		PLOT 8		PLOT 9	
	Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls
1900 ...	194.7	30.5	148.6	31.0	257.9	39.9	209.4	26.3	210.3	31.8	189.3	35.6	220.2	30.4	284.2	33.2	218.6	34.6
1901*.....	89.1	52.7	148.2	54.3	134.4	65.3	105.9	69.7	134.4	58.9	189.0	78.6	98.0	58.3	85.8	52.7	191.2	70.1
1901*.....	71.4	3.0	76.5	3.0	98.2	4.0	72.8	3.1	84.1	4.3	88.2	5.7	64.2	2.3	83.2	3.1	67.1	6.9
1902......	119.4	23.2	87.5	25.6	143.5	31.4	130.0	24.7	119.8	26.1	141.2	33.7	129.1	21.7	138.7	31.9	111.0	32.0
1904......	104.4	23.0	125.6	32.5	120.8	32.7	138.6	28.1	122.6	14.9	135.5	13.8	152.4	15.4	141.0	16.5	138.4	15.1
Average...	115.8	26.4	116.6	29.2	149.7	34.6	131.3	30.3	134.2	27.2	148.2	33.4	132.6	25.6	146.5	27.4	145.7	31.7

* Two crops, one early and one late, were grown in 1901.

would not be so large or so regular in maturing. It was soon discovered that seed produced in Aroostook county, Maine, was about the best that could be procured. This county is in the extreme northern part of Maine and the summer season is short and cool. At the same time it was found that about as good a yield could be obtained from seed that had been grown by planting the small tubers of the early dug crop, and which under favorable conditions would make fair sized tubers late in the fall.

This method of producing seed can be conducted with very good results on the eastern shore of Maryland, and in some sections of Virginia.

It was to test the relative value of seed from these sources that the tests were commenced in the year 1900.

Table II shows the relative yields of home grown summer harvested seed, Maine grown seed, Virginia second crop seed, and Maryland second crop seed, in bushels per acre for six years.

TABLE II

Shows yield of primes and culls for seven years from Maine grown, Maryland early crop, Virginia second crop, and Maryland second crop seed.

VARIETIES	YEAR	MAINE GROWN		MARYLAND EARLY CROP		VIRGINIA SECOND CROP		MARYLAND SECOND CROP	
		Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls
Early Rose.....	1900	173.8	49.9	99.1	59.4	150.3	44.2	177.1	45.5
Early Rose.....	1901	63.8	22.4			106.3	23.0		
Crown Jewel....	1902	147.0	22.0					174.8	15.0
Early Rose.....	1903	107.2	12.8			106.8	10.4		
Irish Cobbler...	1907	123.3	90.7	111.3	78.3				
Early Rose.....	1908	93.4	35.4	98.3	34.8	72.9	38.7		
Triumph.......	1908	122.2	50.8	100.1	44.2	67.4	39.5		
Bovee..........	1908	87.1	33.7	50.8	23.9	60.5	31.3		
Sir Walter Raleigh......	1908	74.7	77.5	91.4	31.2				
Average......		110.2	43.9	91.8	45.3	94.0	31.1	175.9	30.2

A study of the above table shows that for the two seasons the Maryland second crop seed was grown, it gave the best yield. The Maine grown seed was next best, with the Virginia second crop, and home grown summer-harvested, last in the order named. By taking an average of all the varieties through the several seasons, the Maine grown are nineteen bushels better than the home grown, and sixteen bushels better than the Virginia second crop. As all large tubers were used in the test with the home grown lot, it would evidently be more profitable to sell these and save the trouble and expense of storing, and buy Maine grown, or second crop seed.

ORDINARY AND COLD STORAGE SEED POTATOES

The general opinion prevails that the superiority of the Maine grown and second crop seed is due to the fact that the crop is harvested later in the fall and the tubers do not sprout and exhaust themselves as much as the early harvested crop. It would seem, therefore, if such is the case, that stock packed in cold storage as soon as dug, should be in prime condition, in this respect, for planting in spring.

For this test a peck each of four varieties were sent to cold storage. August 30, 1905. A similar lot was stored in a vault which is cool in summer and frostproof in winter. They were left without disturbance until May 20, 1906, when both lots were planted. The cold storage lot were quite firm and solid and had made no signs of sprouting. The ordinary or vault stored lot had sprouted considerably.

In cutting them for planting, no attempt was made to rub off these sprouts, the tubers were simply cut to two eyes and dropped in the row. The ordinary stored lots came up first, but after a couple of weeks no difference could be detected between the two lots.

Table III shows the difference in yields between ordinary storage and cold storage seed calculated to bushels per acre.

TABLE III

Shows yield in bushels per acre of primes and culls from seed kept in cold storage, and seed kept in ordinary storage.

VARIETIES	COLD STORAGE		ORDINARY STORAGE	
	Bu. Primes	Bu. Culls	Bu. Primes	Bu. Culls
Early Rose	81.3	34.9	99.4	39.3
Manistee	90.0	23.2	94.5	45.0
Sunlight	139.2	50.8	113.9	79.1
Clark's Pride	142.1	82.7	139.2	73.2
Average	113.1	47.9	111.7	59.1

The difference in the yields between these methods of storing is ten bushels in favor of ordinary storage. From this one test it does not appear that cold storage would be of very much importance in keeping seed potatoes, when they are to be planted in the early spring.

EXPERIMENTS WITH TUBERS SHOWING WEAK SPROUTS VERSUS OTHERS SHOWING STRONG SPROUTS

It was noticed when planting the variety potatoes which were home grown and harvested in the summer, that many of the varieties had some tubers which were starting with very weak sprouts. It at first looked as though this might be due to absence of light, but upon further investigation, it was seen that this was not the case, for strong vigorous sprouts could be found under the same conditions as the weak ones. In fact both kinds could sometimes be found on the same potato.

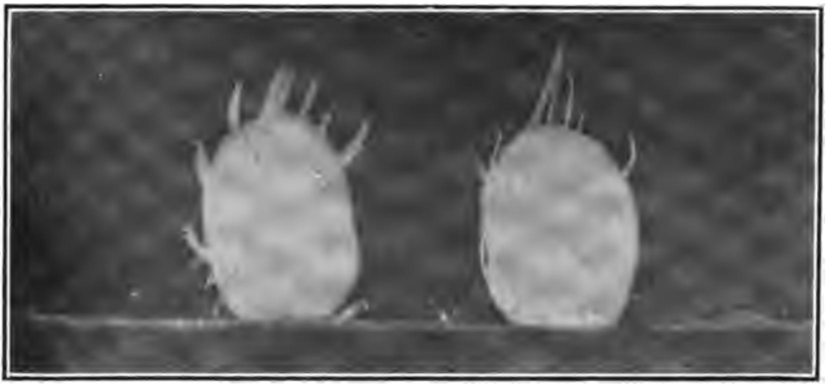


Fig. 1 Potatoes showing the characteristic "strong" and "weak" sprouts. Weak sprouts on the right.

It seemed as though this might be the cause for home grown seed not producing as well as the Maine seed, which always had strong sprouts. Some of the weak sprouted tubers were planted in a separate row alongside of the strong sprouted tubers from the same lot. The tops of the former were weak during the entire season, while the tops of the latter were strong. See figures 1, 2, 3 and 4.

The amount of the yields of the different varieties was in direct relation to the size of the tops as shown in table IV.

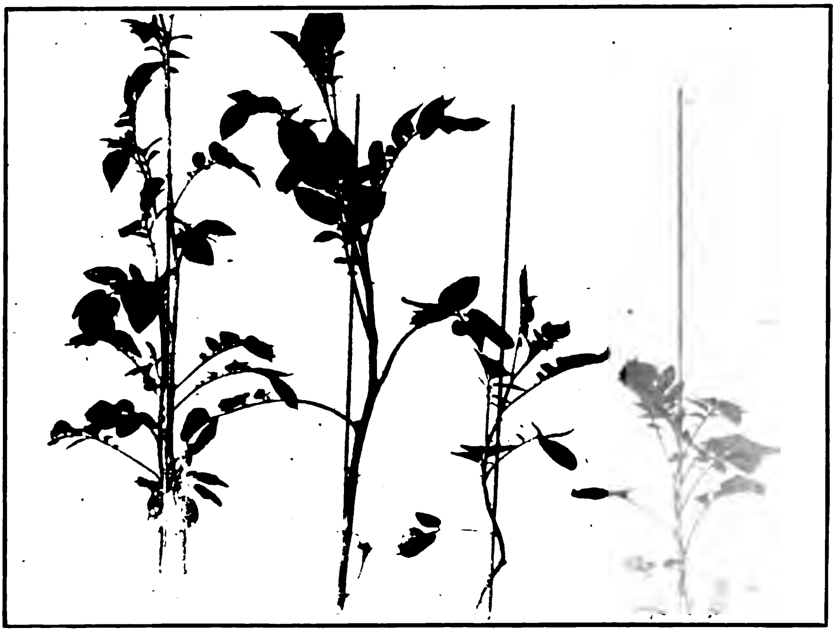


Fig. 2 Plants grown from strong and weak sprouts. Weak sprouts on the right.

Fig. 3 Shows growth of vines from "strong" and "weak" sprout seed. Row marked with a white stake is from weak sprouts.

TABLE IV

Shows yield of primes and culls in bushels per acre from seed with strong sprouts and seed with weak sprouts.

VARIETIES	YEAR	STRONG SPROUTS		WEAK SPROUTS	
		Primes	Culls	Primes	Culls
Early Rose	1907	165.3	107.4	83.2	65.8
Early Michigan	1907	54.2	53.0	21.0	41.3
Triumph	1908	100.1	44.2	59.1	44.2
Sir Walter Raleigh	1908	91.4	31.2	15.3	14.2
Early Rose	1908	93.3	34.8	9.4	18.8
Average		126.0	54.1	37.6	36.8

The above figures show convincingly that it is very necessary to start with a good strong germ or sprout.

The cause for the weak sprouts, is not so apparent. A plausible theory would be that owing to the heat of mid-summer the tuber fails to properly store up the right material for the next year's supply of nourishment to the eye or germ, or it may be a disease that affects the plant under those conditions. A somewhat similar trouble has been noticed in dahlias, and the Easter lily is notorious for a similar weakness.

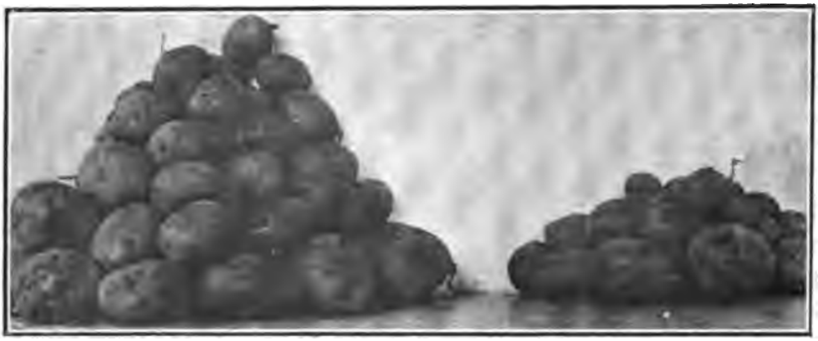


Fig. 4 Shows yield from strong and weak sprouts. Weak sprouts yield on the right.

SEED FROM EARLY PLANTED VERSUS FALL GROWN CROP

Since cool weather seemed necessary for the production of strong germs for producing a good crop the following year, it was thought practicable to produce good seed by delaying planting until the first of August and thus have the crop for next year make its growth in cool weather. This was done in 1906 and again in 1907. The experiment was only a partial success from the fact that the tops died off too soon in the fall, thus defeating the object of having the tubers form in the cool fall weather. The tubers did not grow large, the largest being about the average size of a hen's egg and the smallest the size of a small marble.

In 1907 the seed was planted the first of September. It was hoped by this late planting that the vines would keep green until late fall. This proved to be the case, but an early frost cut the tops at such an early stage of the plants' growth, that no tubers of any account were harvested.

For this reason only two seasons' yields of this experiment are on record, as is shown in table V.

TABLE V

Shows the yield of primes and culls in bushels per acre from summer and fall harvested seed.

VARIETIES	SUMMER		FALL	
1906	Primes	Culls	Primes	Culls
Red River Acme	83.4	29.0	117.4	40.6
Rural New-Yorker	50.7	43.5	152.3	14.0
Early Rose	99.2	39.3	156.6	26.1
Bovee	81.2	47.8	66.7	23.2
Manistee	95.8	45.8	184.1	43.0
Early Market	84.6	36.5	153.7	14.5
Early Michigan	52.9	39.8	106.4	30.9
Sir Walter Raleigh	148.0	37.0	124.8	34.8
1907				
Red River Early Ohio	144.1	23.9	133.4	20.3
Green Mountain	278.0	53.6	284.2	17.4
Red River Triumph	97.1	84.1	112.9	60.9
Manistee	211.7	73.9	159.5	55.1
Home White Ohio	66.7	47.6	139.2	31.9
Red River Acme	71.0	65.2	101.5	43.5
Average	111.7	47.6	142.4	32.4

The table shows that the yields on the average are in favor of the fall harvested seed. It is reasonably certain, however, that if the plants could have been kept growing so that the tubers would have formed late in the fall, there would have been a greater difference.

The crop of tubers when grown by either of these methods is usually small in size. It is, therefore, very necessary to make use of all regardless of size, if they will produce a good crop.

In order to determine the difference between the yields of the several sizes, selections were made and planted in separate rows.

These were graded as egg size, walnut size, and marble size. The yields of the different sized seed tubers in bushels per acre were as follows:

VARIETIES	EGG SIZE		WALNUT SIZE		MARBLE SIZE	
	Primes	Culls	Primes	Culls	Primes	Culls
Green Mountain	284.2	17.4	185.4	23.2	164.4	47.7
Irish Cobbler	90.2	79.2	69.6	33.6	52.8	31.2

The difference in yield is in favor of the larger tubers. This was to be expected. It was remarkable, however, that the small marble sized potatoes yielded so well. Part of the increase in yield of the larger sized seed, was due to a much better stand.

The marble sized tubers usually had but one eye, and if the sprout from this was destroyed there was nothing to replace it.

The egg size tubers had from three to six eyes, thus having a better chance to replace any damaged germs.

Figure 5 shows a photograph of fall harvested tubers as planted the next spring.

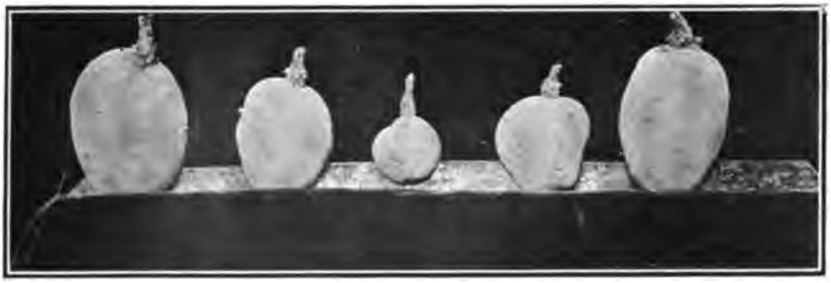


Fig. 5 Shows sample of Fall harvested tubers. Egg size, walnut size and marble size. Note uniformity of size of sprouts

DIFFERENCE IN YIELD BETWEEN EYES CUT FROM BASE AND TERMINAL ENDS

The inspiration for this experiment grew out of several important facts observed in conducting the foregoing work.

It was noticed that the large tubers of the Maine grown seed always start earliest and strongest at the seed or terminal end. See figure 6. These eyes being the last produced would have been developed during the cool weather of the fall.

On the other hand, in several varieties of the home grown summer harvested seed, the earliest and strongest development was at the base or stem end. See figure 7. These would have formed late in May or early in June when the weather was cooler than mid-summer. Theoretically, then, the base eyes of the home grown potatoes and the terminal eyes of the Maine grown potatoes, should produce the best crop. To test this, several long shaped tubers were selected of the varieties Early Rose and Sir Walter Raleigh, Maine grown and home grown seed. These were cut across the center dividing the base and terminal eyes. The pieces were then cut so that two eyes were left to the piece and each lot was planted in separate rows. The growth and yield were about as was expected and the yield is shown in table VI.

TABLE VI

Shows the yield in bushels of primes and culls per acre of the seed end and stem end of Maine grown and home grown seed.

VARIETIES	MAINE GROWN				HOME GROWN			
	SEED END		STEM END		SEED END		STEM END	
	Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls
Early Rose	108.9	26.6	78.7	44.2	74.7	36.3	121.9	33.3
Sir Walter Raleigh.......	82.3	29.6	67.5	25.4	84.2	25.4	95.1	38.4
Average..............	95.6	23.1	72.5	34.8	79.4	30.8	108.5	35.8

This table shows that with the Maine seed the seed end surpassed the stem end yield by 22 and 19 bushels per acre respectively in the order of the varieties given. Likewise the yield of the stem end of the home grown seed exceeded that of the seed end by 44 and 24 bushels per acre respectively.

It may also be noted that the home grown seed produced a larger yield than Maine grown seed.

EXPERIMENT WITH VARIETIES

The primary object of this experiment was to obtain better varieties.

About the time that this work was started the McCormick had been grown for several seasons and had proved a very vigorous, hardy variety and fairly resistant to both blight and beetles. It was also a good cropper. About the only thing against it was its poor quality, especially on some soils. The general opinion was that this variety originally came from Germany. It was thought that perhaps some superior varieties might be found among new importations. Twenty-seven American varieties of northern grown seed, seventeen varieties of French, and eight varieties of German seed were planted in the spring of 1905. To these were added twenty-one varieties in the spring of 1906.

This latter lot were varieties which had been displayed in the State Horticultural Society exhibit and were grown in the western counties of Maryland.

The planting was all done the same day under the same conditions and a different plot of land was selected each season. The planting was done on May 4 in 1905; on May 2 in 1906; on April 14 in 1907; and on April 20 in 1908. The yields of the varieties for the different years and the average yield for that time are given in table VII.

A study of the annual yields as shown by the table will reveal many peculiarities. It shows how inconsistently the different varieties act year after year. This is no doubt due to the varying seasons. A spell of dry weather, or, on the other hand, a good rain, may happen to be just right for the development of one variety and would be too soon or too late for another.

On the whole, it will perhaps be best to depend upon the total average yields as shown in the table. Of the early varieties, or those maturing the first to second week in July, it appears that Irish Cobbler is the best yielder with Noroton Beauty, Clark's Pride, Early Ohio and Early Sixweeks, next best in the order named. These are generally considered good varieties and will evidently do very well under the conditions prevailing here.

With regard to the medium maturing varieties, or those which mature one or two weeks later, Green Mountain stands first and is followed by Rural New-Yorker, Planet, Sir Walter Raleigh, Early Thoroughbred, Early Reliance, Pat's Choice, Montana Prizetaker, White Elephant,

TABLE VII

Shows yield of primes and culls in bushels per acre and the average yield for four years, and the origin of the varieties

VARIETIES	ORIGIN	1905		1906		1907		1908		AVERAGE	
		Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls
Early Maturing.											
Early Ohio	Am.	142.6	6.5	143.6	36.2	46.1	67.5	82.2	43.5	103.6	53.4
Triumph or Red Bliss	Am.	100.1	18.5	58.6	36.5	97.5	83.6	100.1	44.2	86.5	45.7
Irish Cobbler	Am.	210.3	40.6	109.6	56.5	111.3	78.3	116.0	43.5	136.7	53.9
Home White Ohio	Am.	210.1	43.5	115.6	37.0	66.8	48.6	50.8	38.4	85.8	16.8
Noroton Beauty	Am.			146.8	57.9	132.8	105.6	90.7	74.7	123.4	79.4
Early Six Weeks	Am.			141.6	47.9	55.3	78.3	113.2	31.2	103.3	52.4
Maggie Murphy	Am.			102.3	43.5	80.3	78.3	112.0	31.2	98.2	50.6
Red River Acme	Am.	114.3	32.5	83.8	29.3	70.8	64.9	62.4	29.6	82.8	39.0
Extra Early Eureka	Am.	115.6	55.6	47.2	26.1	108.8	69.2	96.3	36.3	92.0	46.8
Early Market	Am.	201.6	24.6	84.6	36.5	42.3	35.4	58.8	31.0	103.3	31.6
Clark's Pride	Am.	150.8	31.9	139.9	73.3	53.3	68.9	101.5	43.5	113.3	54.4
Bonne des Bonnes	Fr.	75.0	41.2	77.0	18.5	123.3	83.8	67.5	18.8	60.2	40.5
Uncle Gideon's Quick Lunch	Am.	58.8	11.6	52.6	58.6	165.0	61.0	74.9	43.5	87.7	43.6
Medium Maturing.											
Early Rose	Am.	209.0	50.8	99.2	39.3	55.6	75.5	98.3	34.8	115.7	48.6
Sixweeks	Am.	137.8	31.9	64.8	45.5	97.2	73.3	58.8	43.5	199.5	64.7
Early Reliance	Am.			196.6	63.2	104.5	92.8	84.2	42.4	128.4	66.1
White Elephant	Am.			174.1	21.0	113.2	49.4	87.1	38.4	124.8	36.2
Planet	Am.			258.1	63.9	113.2	73.3	96.5	37.0	155.6	58.0
State of Maine	Am.			101.9	33.3	165.0	63.9	98.2	31.2	121.7	42.8
Rural New Yorker	Am.	207.6	33.8	50.8	50.6	113.2	36.8	96.5	29.7	156.0	50.3
Ionia Seedling	Am.	48.6	14.5	69.7	17.3	99.2	72.6	91.4	34.8	102.9	46.4
Pat's Choice	Am.	165.0	10.9	137.9	57.6	92.8	68.3	110.7	29.7	126.6	41.6
Early Thoroughbred	Am.			293.6	55.6	20.2	70.8	82.3	34.8	132.0	50.0
Early Jersey	Am.			136.5	60.4	111.0	95.8	84.2	39.5	110.5	65.2
Green Mountain	Am.			301.6	12.3	278.6	53.7	61.7	33.3	213.9	33.1
Carman No. 1	Am.			67.9	145.6	168.2	116.3	73.3	34.8	103.1	98.9
Montana Prizetaker	Am.	184.6	26.2	66.8	90.0	130.2	87.1	116.9	39.5	124.6	60.7
Manistee	Am.	95.7	37.8	95.8	45.8	211.6	73.3	70.3	31.2	118.5	47.0
Pingree	Am.			108.9	75.5	55.6	75.5	105.9	31.0	90.1	60.6
Min. Von Miguel	Ger.	113.2	48.8	43.3	75.5	63.8	116.3	72.6	39.5	73.2	70.0
Fornheim	Am.	124.6	50.8	72.6	69.6	59.3	104.6	74.7	36.3	85.3	65.2
World's Fair	Am.	37.5	15.9	71.8	97.2	109.6	107.4	65.3	31.0	70.5	62.8
Crines Lighting	Am.	59.3	10.1	118.9	50.6	107.0	52.2	110.8	26.6	99.0	34.8
Le Milleure de Belleville	Fr.	30.8	14.5	20.3	14.8	95.7	63.9	73.3	22.2	55.0	28.7
Bovee	Am.	137.8	46.4	75.3	47.9	49.3	56.0	50.8	23.9	78.3	43.5
Sir Walter Raleigh	Am.	204.0	37.8	148.0	37.0	127.6	87.1	91.4	31.2	142.7	48.2
Early Michigan	Am.			52.9	39.8	37.8	49.4	76.3	40.6	55.3	43.2
Late Maturing.											
The Clinton	Am.	101.9	18.9	103.2	18.9	107.8	56.5	52.9	13.2	182.9	53.7
Constellation	Fr.	55.6	19.4		78.3		127.0	40.6	58.0	24.0	70.6
Eiffel Tardive	Fr.	24.6	18.9	14.5	55.6	46.4	143.6	18.8	14.5	26.0	58.1
Agnelli	Fr.	113.0	27.5	67.5	111.2	204.4	104.0	90.7	14.5	118.9	64.3
La Czarina	Fr.	31.9	2.3	28.3	4.7	33.3	20.2		33.3	23.4	15.1
Dr. Von Ecken Becker	Ger.	84.6	21.9	91.5	63.9	150.9	70.7	91.4	10.9	99.6	41.8

TABLE VII—*Continued.*

VARIETIES	ORIGIN	1905		1906		1907		1908		AVERAGE	
		Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls	Primes	Culls
Late Maturing.											
Graminee	Ger.	78.3	8.8	40.6	28.3	168.2	70.8		34.8	71.7	86.1
Professor Maerker	Ger.	49.4	28.2		41.3	63.9	78.3	23.9	33.2	42.7	37.3
Ed. Lefort	Fr.	78.3	21.7		15.9		69.7	24.2	13.2	25.1	30.1
Bund der Landwirt	Ger.	77.0	15.9	41.3	30.5	90.0	91.7	44.2	12.0	63.1	37.5
Jardiniere	Fr.	80.3	24.6		41.0	54.2	56.5	18.8	18.8	38.5	35.2
Pouisse Debout	Fr.	49.4	20.3	36.8	36.2	46.4	77.2		34.8	32.6	42.1
Duchesse	Fr.	78.3	49.4	90.7	57.6	179.8	70.8	72.6	15.7	105.3	48.1
Farineuse Rouge	Fr.	56.8	8.8		20.3	109.5	36.2	43.5	12.5	38.5	19.4
Professor Jules Kuhn	Ger.	46.8	36.8		26.1		233.8		58.0	11.7	88.6
Canada	Fr.	233.0	50.8	90.0	15.9	139.0	99.8	101.8	29.7	140.9	48.5
Leo	Fr.	79.1	11.3	32.5	90.0	165.0	97.9	103.9	14.5	95.1	53.4
Geheimrath Thiel	Ger.	52.2	30.5		23.2	49.7	121.2	70.3	38.4	43.0	53.3
Prolific Tardive	Fr.	122.9	17.4	47.9	87.8	107.3	45.8	68.7	12.5	86.7	40.8
Professor Wohltmann	Ger.	56.5	21.7		107.4	101.9	110.8	15.0	22.2	43.3	65.5
Vigorosa	Fr.	82.0	11.3	46.6	88.5	113.2	69.6	40.6	12.0	70.6	45.2
Fleur de Pecher	Fr.	62.1	33.3	5.8	61.0	132.0	113.2	33.3	23.9	58.3	57.7
Carola	Fr.		15.8		8.8	46.4	34.9	76.7	38.4	30.7	24.1
Magnum Bonum	Fr.	58.0	37.6		15.9		49.4	23.3	25.1	2.3	32.8
Livingston	Am.	20.7	26.2	132.0	50.8	101.9	54.2	19.2	7.9	68.4	34.2
McCormick	Am.	77.0	31.9	123.2	124.5	165.0	107.3	130.6	88.9	123.9	88.1
Banner	Am.	129.5	20.2	145.0	43.8	83.8	60.9	108.9	14.5	116.3	34.9
Peach Blow	Am.			37.8	13.6	83.3	36.2	65.7	79.8	62.2	43.6
Mark Hanna	Am.			75.3	36.8	127.7	72.6	56.6	7.9	53.2	39.0
Oom Paul	Am.			182.9	122.7	95.8	95.7	73.3	33.3	117.3	83.3
Pride of America	Am.			159.9	40.6	118.9	70.8	98.2	29.7	125.6	11.8
Uncle Sam	Am.			116.8	43.8	66.8	63.9	90.7	33.3	91.4	47.4
Blush	Am.			77.0	40.6	284.6	60.9	186.6	72.6	182.7	58.0
Commercial	Am.			123.2	43.8	83.8	60.9	108.9	27.3	105.3	44.0
Blue Peerless	Am.			219.8	20.3	233.8	90.7	115.8	29.7	189.8	46.9
No Bug	Am.			34.9	43.8	122.0	70.8	88.9	23.9	81.9	49.4
Solanum Commersonii					53.6	122.7	56.0	50.8	14.5	57.8	41.3

State of Maine, Sixweeks, Manistee and Early Rose in the order named.

Of the later maturing varieties the Blue Peerless heads the list, with Blush, Clinton, Canada Pride of America, McCormick, Oom Paul, Agnelli, and Banner following. It was expected that the McCormick would make a better showing as it is considered a wonderful cropper. It would perhaps show up better in competition if planted late.

None of the German or French varieties were notable in any way to make them valuable here.

REVIEW AND CONCLUSIONS

It seems safe to assume that working potatoes with a five shoveled horse cultivator about twice or three times, is good practice for conditions such as prevailed here. The Maine grown seed potatoes always produced better yields than home grown seed. From the experiments that bear upon this phase of the question, it would seem that it is not so much where the seed is grown as it is a question of climatic conditions. In other words, the best condition for the development of a strong germ, is cool weather, and a strong germ is one of the necessities for a good crop. Varieties like Early Ohio and Red River Acme that form their tubers early in the summer, or late planted Blush and McCormick that form tubers late in the fall, can be planted year after year without apparent deterioration. For the same reason the eyes from the base or stem end of the home grown largest sized tubers, produced better than the terminal or seed end. And the seed or terminal end of the Maine grown did better than the base or stem end.

In this locality the base eyes of the largest tubers of varieties like Early Rose or Sir Walter Raleigh are in process of formation in early summer, while the seed end is the last to form in mid-summer. On the other hand, in climates where it takes the entire summer season for a crop of potatoes to mature, the base eyes would form in the hotter weather and the seed end eyes in the cooler fall season.

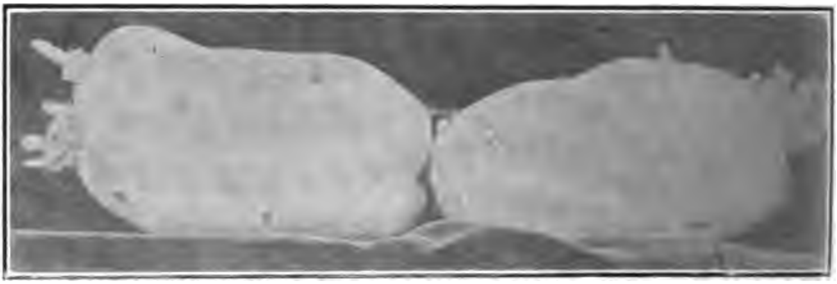


Fig. 6 Maine grown tubers showing strongest sprouts on the seed end.

It is sometimes recommended that the cluster of eyes on the seed end be cut off and not used. This would be bad practice in the case of Maine grown seed.

The difference in opinion found among potato growers with regard to what is the proper sized seed to plant, may be partially ascribed to some of these conditions. Thus, if the potatoes were planted early in the spring and matured in mid-summer, the earliest formed tubers would be the largest and the later formed ones would be small. In this case the large tubers cut would produce the largest crop. On the other hand, if the plants were grown in a cool climate, or were planted late in the summer, then the smaller tubers would have formed under the most favorable conditions and should produce the best crop.

A very important point in saving home grown seed is to look carefully for any tubers that may be attacked with the "small sprouts" disease if such it is. This can be found in a great many varieties especially those that mature in mid-summer such as Early Rose, Early Thoroughbred, Sir Walter Raleigh and Green Mountain. Home grown seed will probably have sprouted some by planting time and by carefully looking them over the affected ones can be easily seen.

Any seed showing the thin thread-like sprouts such as appear on the right hand tuber on figure 1 should not be used.

This condition has not been noticed with Maine grown, or second crop seed.

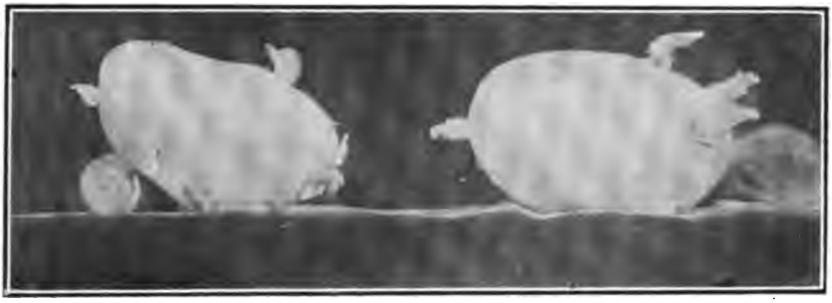


Fig. 7. Home grown tubers showing strongest sprouts at base end.

On the whole where potatoes are to be made a special crop and grown in quantity, it would be most profitable to purchase seed grown in a cool climate. If home grown summer harvested seed must be used, then it will be best to use the large tubers cut to two eyes. These under ordinary storage will have sprouted somewhat by planting time, and any showing weak sprouts should be rejected.

CULTURAL DIRECTIONS

Potatoes for the nearby market as well as for long distance shipping from the eastern shore to Philadelphia and New York, are considered quite a profitable crop in Maryland. These are mainly the early varieties, and the yield ranges all the way from eighty to three hundred and fifty bushels per acre. The farmers in the northern and western counties of the State grow a good many potatoes, but these are generally of later varieties. When an early crop is grown, it is usually planted as soon as the ground can be worked. The late crop is planted in some localities as late as August first.

Soil. A sandy loam well enriched is considered best for this crop. Vegetable matter is needed, but it should be in a thoroughly well rotted condition. Any vegetable matter in a state of decomposition, seems to foster the increase of the potato scab fungus.

Previous treatment of the soil. There is no doubt that the largest yields of potatoes are grown upon soils that have been annually manured for some years previous, and that have not been planted to exhausting crops like field corn.

It is good practice to plan a rotation and manure heavily the crop that precedes potatoes. Cabbage likes a liberal supply of manure, and as fresh manure seems to be suitable for this crop, it could be used freely for the cabbage and would then be well decayed for the potatoes which follow. The potatoes could be succeeded by grass and clover, or wheat with grass, which could be followed by cabbage again, and so on.

If a heavy sod is to be used for early potatoes, it should be plowed in the fall because if spring plowed it cannot be gotten into condition. A thin clover sod might be all right broken in the spring.

Manuring, If as stated above, potatoes follow some crop that has been well manured, commercial fertilizer is all that will be needed to get an early crop. A fertilizer with 7 to 9 per cent of phosphoric acid, 3 to 4 per cent of nitrogen, and 4 to 5 per cent of potash, will give good results.

A good formula for this is the following:

	Pounds
Dissolved Phosphate Rock	1000
Dried Blood	600
Nitrate of Soda	200
Sulphate of Potash	200

If wanted for a late crop the nitrogen need not be as readily available and the following formula may be used:

	Pounds
Dissolved Phosphate Rock	1000
Dried Blood	800
Sulphate of Potash	200

Either of these formulas should be applied broadcast at the rate of fifteen hundred pounds per acre, and be well mixed into the soil with harrow or cultivator.

If it is thought desirable to stimulate the growth of the young plants, one hundred pounds each of nitrate of soda and dissolved phosphate rock per acre, should be scattered in the row when the seed is planted. The potato, having to make its growth in such a short time, needs its food in a readily available condition. The formulas above provide for a generous amount of soluble phosphoric acid which is necessary to make the plant mature in a short time. Early maturity is very important, not only on account of being able to get the crop on the market as soon as possible, but also because some of the early varieties cannot withstand the moisture and heat of early summer, and if the vines are injured by "tip burn," or blight of any kind, the tubers are sure to be undersized.

If it should ever be necessary to use fresh or partly decomposed stable manure for Irish potatoes, then dissolved phosphate rock should be used quite liberally with it. Eight to ten hundred pounds per acre would not be too much if stable manure had been liberally applied. Fresh manure is to be avoided, however, an account of its tendency for increasing the "scab." Lime and wood ashes, while being excellent in general for most soils, should be used with caution for this crop, for the reason that the scab fungus seems to thrive in a neutral or slightly alkaline soil. The acid in the phosphate rock tends to keep the soil slightly acid, a condition favorable to the potato and unfavorable to the scab.

Preparation of the soil. The soil should also be thoroughly prepared mechanically. The plowing should be well and carefully done to the depth of eight inches. As a general thing not enough attention is paid to this matter of plowing. If the subsoil is clay, the drainage can be improved very much by plowing to a uniform depth with a large two horse plow in the direction the land slopes. The bottom of the landside of a large plow makes a runlet for the water. A wheel should be used to secure uniform depth. After plowing, the soil should be thoroughly pulverized by disc harrow or otherwise, to the depth of five inches.

Planting. Plant in furrows three to four inches deep made with a plow. Cover by throwing two furrows on top of the seed. If a planting machine is used, set it to plant the same depth. This method of covering allows for two harrowings which mellow and level the soil before the growth appears.

Seed. The importance of good seed can scarcely be over-estimated. For a good crop of early, uniform tubers, there must be a good start. According to experiments here it is necessary among other things, to start out with a good strong vigorous germ. A vigorous germ or eye can only be secured on some varieties by that germ being formed in a cool climate, or in the fall of the year when the weather is cool. For this reason, growers in the southern part of this state and in the potato growing section further south, should either secure their seed from northern Maine or Michigan, or else replant tubers of the first crop and thus grow their own seed which is called "second crop" seed. The reason that growers in a hot climate felt the necessity of getting their seed from the North, or growing the "second crop," was somewhat obscure until the experiments at this Station during the past three years threw some light upon the matter; see pages 156, 157 and 159.

These experiments showed the need for strong germs or eyes to secure a good crop. Evidently cool weather with a proper amount of moisture is what is needed to produce a strong germ. These conditions may generally be found in the lower sections of Maryland before the first of June or after the last of September. Eyes formed at that time will produce as good as northern grown seed.

Second Crop Seed. The seed called second crop is grown in the following manner: The small unsalable tubers of the June crop should be spread out thinly in a shady place. In two or three weeks they will have turned very green and the larger ones should be cut and the others have a piece taken from the side. It seems that mutilation has a tendency to hasten the development of sprouts. They should then be spread in the sun covering them thinly with earth or sand. After sprouting commences they should be planted in the ordinary way.

If favorable weather conditions prevail, a crop of tubers from the size of an egg to a marble will be harvested late in the fall. These will all make good seed with strong eyes or germs. Another thing in favor of this late harvested seed is that it will not sprout until spring, and thus the first sprouts, which are usually the best, will be saved.

This will be thought by some growers to be too troublesome to practice, but for varieties like Early Rose, or any of the medium maturing varieties, it will be necessary to do this, or get seed from a cooler climate. If seed potatoes are large, they should be cut, for nothing is gained by planting large potatoes. Practically, if there are strong single stemmed plants one foot apart in the row, the largest amount of salable tubers will be produced. Theoretically, pieces of potatoes cut to one eye dropped at that distance would produce these results, but in experience, however, this has not proved to be so, for very often if weather conditions are not just right the small pieces of potatoes decay or dry up before the sprouts have attained sufficient strength to support themselves. To insure a good crop the safest plan is to cut the potatoes so that there will be at least two eyes upon each piece.

It will be found that if the pieces of the seed end and the pieces from the stem end are planted separately a more uniform stand will be insured. The eyes of the seed end sprout quicker than the eyes of the stem end and if they are separated it will be much better for cultivation and harvesting.

This separation of the eyes will not be necessary where second crop seed is being used as these usually start out with one strong germ from the seed end, and about all the cutting needed is to divide the larger tubers in half lengthwise. If home grown seed, aside from second crop is to be used, it should have strong sprouts and be grown in cool weather.

Bud variation is quite common in plant life and potatoes sometimes vary in this way. It will, therefore, pay to go through the patch when the growth is about made or when the plants are in bloom, selecting and marking with a stake those which are most vigorous and healthy. These should be dug and stored separately from the general crop. If it is considered too troublesome to save enough to plant the entire crop this way, enough hills should be marked to produce several bushels. These may be planted separately and all the products be used for seed the following year.

Quantity of seed per acre. This will vary according to the size of the tubers. If large potatoes with few eyes are used, twelve to fifteen bushels are necessary, and if medium to small potatoes with plenty of eyes are planted, only eight to twelve bushels will be needed.

Cultivation. If the seed is covered with a plow the land will be left in a ridged condition. A week or two after planting, these ridges should be leveled down with a board or clod crusher. Just as the plants appear a smoothing harrow should be used to level the ground and kill the weeds. Very often, especially in late crops, it is not necessary to do any hand hoeing if this harrowing is thorough. Cultivation can be done with an ordinary five shoveled Iron Age or similar cultivator. Small shovels can be used the first time, stirring the soil deeply. At the last cultivation a broad shovel behind will work about the right amount of earth up to the hills.

Harvesting. As a general rule potatoes should not be dug until the vines mature and die, as the tubers will increase rapidly in size after the vines begin to turn yellow. After the vines are dead there is nothing gained by leaving the crop in the ground.

It is best not to dig if the sun is bright and the weather extremely hot for the tubers are easily scalded. The digging should be done in cloudy cool weather if possible.

There are several potato diggers on the market and where everything is in proper condition, with no rocks, weeds, or anything that will hang or clog, good work can be done with them. Many small growers, however, depend upon the plow and potato hook. A large one-horse, or small two-horse, plow set at just the right depth to run beneath the potatoes without cutting them, will turn the hills bottom side up so the tubers may be easily removed with potato hooks.

The grading may as well be done in the field even though the crop is not to be sold at once. The grades should be firsts, seconds and culls. Only the firsts should be shipped to distant markets, the seconds had better be disposed of near home. The culls can sometimes be sold to bakers who use them in connection with yeast in bread making.

When shipping to early markets, barrels or boxes must be used, as there is much less danger of bruising and heating than if placed in sacks. For the late crop, sacks are often used and are quite economical. One and one-half bushels are usually put into each sack.

Storing. Potatoes should be placed in the dark as soon as possible after digging. Light will turn the skins green and bitterness will extend into the flesh, making them very unpalatable. A temperature at or a few degrees below 40° F., will keep potatoes in good condition. Cellars under barns or dwellings or specially constructed vaults or caves, are often used. The storage place should be easy to ventilate, but need not be extremely dry. Storage in kilns or pits is often practiced, and where there is no frostproof building it is very cheap and convenient.

For a pit or kiln a high and well drained spot should be selected. Scrape away an inch or two of soil and cover with a layer of dry straw. The potatoes should be piled upon this, not more than ten bushels in the pile, and be covered with straw and one foot to fourteen inches of earth. Only sound potatoes should be stored in this way. If there is the least sign of rot the crop should either be sold at once or stored in boxes where they can be picked over occasionally.

Varieties. The selection of varieties must be governed by the market demands. Three very popular varieties at present are, for extra early, Early Ohio; for medium early, Irish Cobbler; and for main crop, Green Mountain. These are all of good quality and sell well. For yields of other varieties see pp. 164 and 165.

DISEASES

Early blight. Brown spots with faint rings in them appear on the leaves. These gradually cover the leaf, killing it. Spray with Bordeaux mixture three times between June 15 and digging time in the fall. The McCormick potato is not much troubled with this disease.

Late blight. In moist summer weather, late blight appears suddenly as soft, bad smelling, dark areas in the leaves and may kill whole fields in a short time. It is not common in this state. The treatment for this disease is the same as for early blight. The affected tubers may rot.

Brown rot. The leaves and stem wilt and shrivel and the tubers later show a wet rot. Thorough spraying with Bordeaux mixture and arsenicals is necessary to keep down insects which carry the germs. Do not plant on land which has recently borne potatoes, tomatoes or egg plant, all of which are subject to the disease. Store potatoes in cool, dark places.

Dry rot. This disease causes lighter colored and more or less rolled up leaves. The tubers later may be destroyed, at least at one end. by dry rot. Avoid infected soil and do not plant tubers that have internal brown or black streaks.

Scab. Scabby spots develop on the tubers. Soak uncut seed tubers in formalin, one-half pint to fifteen gallons of water, for two hours, and plant on scab free land. Avoid the use of alkaline fertilizers.

THE MARYLAND
Agricultural Experiment Station

BULLETIN NO. 133 May, 1909

CABBAGE EXPERIMENTS AND CULTURE

BY C. P. CLOSE AND T. H. WHITE

INTRODUCTION

The cabbage crop in Maryland is a very important one. Large quantities are grown for the markets of Baltimore and Washington and for the smaller markets throughout the State. It is used for immediate consumption and for making into sauerkraut.

This Experiment Station has been testing varieties for the past ten years. Wet and dry seasons have been experienced and these have given good opportunities for noting the behavior of the different varieties under these conditions. Experiments have also been made with fertilizers and soils, and some notes as to the resistance of types and varieties to disease, have been made. Seeds of French varieties were imported and tested along with the American kinds.

EXPERIMENTS

An outline of the several experiments may be briefly stated as follows:

Experiment No. 1. To note the effect of soil treatment, that is, with stable manure and chemical fertilizers, and their relation to cabbage diseases.

Experiment No. 2. The value of a high priced fertilizer compared with a lower priced, poorer grade.

Experiment No. 3. The effect of excessive amounts of the various fertilizing elements applied to the seed bed.

Experiment No. 4. The resistance of varieties to disease.

No. 1. EFFECT OF SOIL TREATMENT ON CABBAGE DISEASES.

The susceptibility to rot and disease of cabbage growing on very rich, highly cultivated land, seemed to be due more to something unsuitable in the soil rather than to the direct attacks of bacteria or fungi. During very rainy weather in the heat of summer, young and apparently vigorous cabbage plants will wilt and die. If the weather is moderately dry and the soil loose and well cultivated, cabbage will grow vigorously and seemingly resist disease even if the soil is known to be infected with germs. It was noticed that a patch of cabbage planted on a piece of land that had been used to grow celery for several years, grew very well until heavy rains began to fall in August. In the bright sunshine which followed, the plants wilted and many afterwards died.

The crop was a failure except a portion of the lower corner which was on a poor clay knob and there a few good heads matured.

Due consideration was given to the fact of poor drainage and also to excessive amounts of water about the roots to which might be attributed much of the failure. Still it seemed a plausible conjecture that there might be extraordinary amounts of soluble salts in the soil and that they would have a poisonous effect on the cabbage roots.

The first experiment bearing upon this point was made in the summer of 1905. A piece of rather stiff clay land, one-eighth of an acre in size, that had been manured and planted to truck crops for many years and upon which cabbage had rotted badly the preceding year, was again treated with ten tons per acre of rotted manure. This was plowed down and the land was prepared for the crop.

Plots were marked off and treated as follows:

Plot 1. Complete fertilizer, 1000 pounds per acre,
Plot 2. Check, no fertilizer.
Plot 3. Lime, 60 bushels per acre.
Plot 4. Sulphate of potash, 300 pounds per acre.
Plot 5. Muriate of potash, 300 pounds per acre.

It had been noticed in some other work under similar conditions that muriate of potash seemed to have the effect of promoting the vigor of the plants. Fifteen varieties of cabbage were planted across the plots, nine varieties of French and six of American origin. The plants were set June 23. They started off nicely and grew well until the first week of August, at which time there were incessant rains followed by bright sunshine.

All the plants on all the plots wilted down and only a few recovered. Most of those wilted died in a short time with black rot. A few lingered on, but did not make any satisfactory heads. The results from either of these treatments seemed to be negative. The same season other small plots under the same conditions were treated with potash as follows:

Plot 1. Muriate of potash, 300 pounds per acre.
Plot 2. Muriate of potash, 600 pounds per acre.
Plot 3. Muriate of potash, 900 pounds per acre.
Plot 4. Check, no fertilizer.
Plot 5. Sulphate of potash, 300 pounds per acre.
Plot 6. Sulphate of potash, 600 pounds per acre.
Plot 7. Sulphate of potash, 900 pounds per acre.
Plot 8. Lime, 60 bushels per acre.
Plot 9. Common salt, 200 pounds per acre.

Twelve plants of Premium Flat Dutch cabbage, that had been grown in beds treated with the same kind and amounts of fertilizers used on the plots, were set on each of these plots, June 23. They started off and grew well until the excessive rains came on. As a result, most of the plants wilted badly except those on the plots receiving muriate of potash. The excessive rainfall continuing, many of the plants on all the plots became affected with rot and died. At the time of maturity in the fall the results were:

Plot 1. 6 alive, 4 good heads.
Plot 2. 3 alive, 3 good heads.
Plot 4. 3 alive, 0 good heads.
Plot 5. 4 alive, 0 good heads.
Plot 6. 9 alive, 0 good heads.
Plot 7. 7 alive, 1 good head.
Plot 8. 7 alive, 2 good heads.
Plot 9. 6 alive, 0 good heads.

Under these conditions none of the treatments seemed to be of much benefit. Even lime, which is considered by many to be a "cure all," failed to give any positive results. In order to further investigate this matter, the same piece of land was manured and plowed and let lay rough all winter. In the spring, rows were laid off with a plow across the plots of the previous year and manure and fertilizer were applied in the rows as follows:

Row 1. 10 tons of fresh manure per acre.
Row 2. 1000 pounds dissolved phosphate rock per acre.
Row 3. 600 pounds muriate of potash per acre.
Row 4. 1000 pounds dried blood per acre.
Row 5. 500 pounds dissolved phosphate rock, 300 pounds muriate of potash, 500 pounds of dried blood per acre.
Row 6. 300 pounds common salt per acre.
Row 7. Check, nothing applied.

Wishing to note the effect of throwing up ridges and planting on them, thus giving a better opportunity for drainage, half of the patch was ridged. The other half was leveled and the plants were set. Henderson's Succession was used and the cultivation was done so as to maintain the ridges and level ground throughout the season as planned.

The season again proved very wet and in August the plants began to die. On account of the spongy condition of the soil the ridges were continually saturated, but no water stood around the plants, as it did in pools on the level culture during heavy downpours. Under these conditions the plants became affected and died off until all were dead on the level culture portion. Out of the 35 plants set on each ridge row not one produced a good head, but the following numbers were alive in late September.

Row 1. 8 plants
Row 2. 8 plants.
Row 3. 0 plants.
Row 4. 6 plants.
Row 5. 5 plants.
Row 6. 4 plants.
Row 7. 8 plants.

These experiments failed to show that any benefit could be derived from using these various materials and cultures as correctives of the supposed excessive salts or poisonous matter in the soil. Meanwhile good cabbages were being grown on other parts of the farm on the same character of soil and drainage, with the exception that the land had been in sod from which hay had been cut.

Thinking that probably grass when cut from hay corrects conditions otherwise unfavorable for cabbage, and since it was impossible to produce sod on the plot in a short time, wheat was sown on one-half of the plot in the fall of 1906 in the hope that it would have an influence similar to the supposed influence of grass. The wheat, though planted late, grew well and its heavy growth of straw and dark green color gave evidence of the fertile condition of the soil. The other half of the plot upon which nothing was sown was disced in the spring to keep down the weeds.

The wheat was taken off July 6 and the whole plot was immediately plowed, rolled, and harrowed. On July 12 the plants were set and nine varieties were used in the work.

The season was favorable and during the critical period of August and early September it was comparatively dry. For the first time in four years some good heads of cabbage were grown on this plot. A good many plants of some varieties died as usual, but on the whole there was much improvement. The half of the plot producing wheat contained 308 good heads at harvesting time and the other half contained 363 good heads from the 540 plants set on each half. This would indicate that a crop of wheat did not have the effect of sod on the cabbage crop, for the wheat growing half of the plot produced 55 heads less than the other half.

Surplus available nitrogen. A secondary experiment was carried on at the same time to determine if a surplus of available nitrogen would tend to make the plants less disease resistant, or otherwise affect the crop. The plot was divided into halves across the wheat stubble and the other part. One-half received a mixture of fertilizers rated per acre as follows;

	Pounds
Dissolved phosphate rock	800
Kainit	320
Tankage	320
Nitrate of soda	320

There seemed to be no difference between that portion of the plot from which the crop of wheat had been taken and the other part.

The plot receiving nitrate of soda produced 322 good heads and the other plot produced 349 good heads. This is a difference of only 27 heads and may be an indication of the presence of too much soluble nitrogen in the soil.

The comparative disease resistance of the nine varieties grown is discussed under "Resistance of Varieties to Disease."

As nothing definite had been accomplished to improve soil conditions by any of the treatments mentioned above, this feature of the work was left out in 1908, and without further manuring or fertilizing late cabbage was planted on this plot. Seventeen varieties were included for a test of varieties and disease resistance.

The season was again quite dry at the critical time in August and some varieties lost but few plants while other varieties lost nearly all. Out of 612 plants set, only 380 reached maturity, the others being killed by disease.

THE RESISTANCE OF VARIETIES TO DISEASE

While doing the variety testing, attention was called to a variety said to be free from rot which was being grown by the truckers near the Experiment Station. This proved to be Landreth Market Gardeners Large Late Flat Dutch. There were also some other varieties that were disease proof to a remarkable degree. It was noticeable also that this disease resistant stock all conformed to one type, of vigorous growth, with green or purplish green curled and crinkled leaves. It seemed to be very hardy, as it stood in the field throughout the winter and produced seed in the spring.

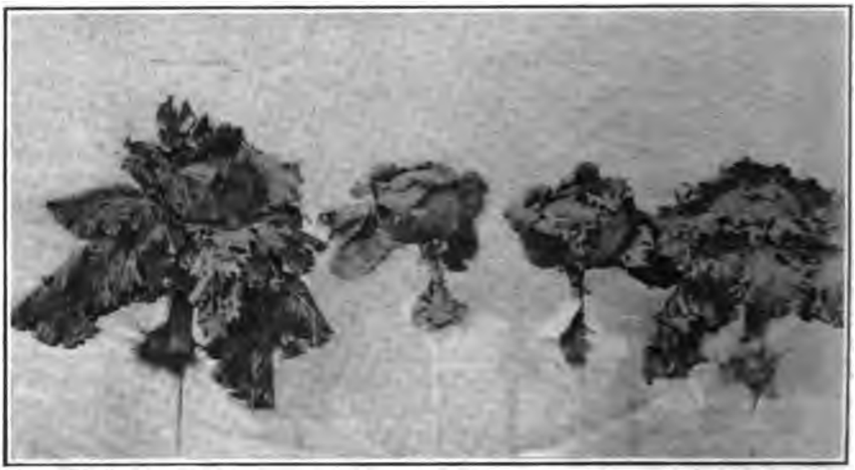


Fig. 1 Showing two types of Flat Dutch Cabbage. The two outside heads are the purplish green resistant type, and the two inside are the whitish green less resistant type. Note the amount of outside leaves retained by the resistant plants.

It was also noticed that cabbages of the Savoy type were very disease resistant and usually stood conditions that would destroy cabbage of the ordinary Flat Dutch type.

The ordinary Flat Dutch type of cabbage has plain leaves, whitish green in color. Some varieties grow very large and for late use have been very popular on the markets. There seems to be much mixing of types in the different varieties sent out by the various seedsmen. Two seedsmen may send out seed under the same name and yet the cabbage will be of different types. For instance, Landreth Autumn Giant has the dark purplish green curled leaf of his Flat Dutch, while Henderson Autumn Giant is of the ordinary Flat Dutch type of plain whitish green leaf. Market gardeners who wish to grow cabbage and have only very rich, well cultivated land where rot is liable to be troublesome, should plant cabbage of the purplish green and Savoy types for their late crops.

For early planting no special selection is needed, as most early cabbages are mature and marketed before the unfavorable weather conditions begin. For the benefit of those who wish to know the different types as far as they have been tested here, the varieties have been arranged under three headings as follows:

Type 1. These are large, vigorous growing, purplish green, curled and crinkled leaf cabbages. They are most resistant to diseases. Some varieties are Landreth Market Gardeners Large Late Flat Dutch, Landreth Surehead, Landreth Autumn King, Burpee Autumn King, Burpee Surehead, Illinois Winter Market and Houser.

Type 2. The Savoy type has curled, crinkled, and netted green leaves. They are fairly disease resistant. Some varieties of this type are Perfection Savoy, Ironhead Savoy and Brunswick Netted Savoy.

Type 3. These are plain, whitish green leaved varieties, easily affected by disease. Some of these are Henderson Matchless Large Late Flat Dutch, Henderson Selected Large Late Flat Dutch, Marblehead Mammoth, Maule Prize Flat Dutch, Succession, Wood & Sons Autumn King, Henderson Autumn King and Bolgiano Premium Flat Dutch.

As a sub-type of similar character and even less resistant may be mentioned the round headed varieties such as Danish Ball Head, Summer Danish Ball Head, and Hollander or Danish Ball Head.

HIGH PRICED AND LOW PRICED FERTILIZER

In experimental work with fertilizers it was noticed that a mixture relatively low in nitrogen and potash and therefore low in price would sometimes give as good results as a higher priced article. This is also often the experience of farmers.

It is a well known fact, in practice, that kainit applied to crops often increases the yield far in excess of what could be attributed to the small amount of potash it contains.

The first experiment bearing on this subject was tried on late cabbage in the season of 1907.

The soil used was a clay loam located on a piece of level bottom land. It was in mixed grass sod and a crop of hay had been taken off annually for the past five years. It was quite fertile and would probably produce sixty bushels of corn or twenty-five bushels of wheat per acre.

The land was plowed early in the season and was occasionally harrowed until within a week of planting time, when the fertilizer was sown broadcast and harrowed in.

The fertilizer formulas were as follows.

Plot 1. High priced goods, amounts per acre.

	Pounds	*Analysis*	*Cost*
Dissolved phosphate rock	240	Phosphoric acid....4 to 5	$16.70
Nitrate of soda	120	Nitrogen..........8 to 9	
Dried blood	400	Potash............6 to 7	
Muriate of potash	100		

Plot 2. Low priced goods, amounts per acre.

	Pounds	*Analysis*	*Cost*
Dissolved phosphate rock	400	Phosphoric acid ....7 to 8	$ 7.70
Tankage 7 per cent	300	Nitrogen 2 to 3	
Kainit	120	Potash..........1 to 2..	

The cabbage was all of the same variety and planted on the same day. Cultivation was similar all through. A good crop was harvested.

The yields were as follows:

	Plot 1		*Plot 2*
Pounds	31460	Pounds	31944
Value	$157.30	Value	$159.72

The yields were practically the same, being slightly in favor of the low priced fertilizer.

The next experiment bearing on this matter was tried in the season of 1908. The piece of land, a light clay loam, had been in timothy grass which had given way to wild grasses. Hay had been taken from the plot the year before, and the stubble was turned down in the early spring. The land was thoroughly prepared, the fertilizers sown, and the cabbage planted July 22.

In this case plot No. 1 was a check plot with nothing applied. Plot 2 was given the same high priced fertilizers as plot No. 1, in 1907. Plot 3 was given the same low priced fertilizers as plot No. 2 in 1907.

The season was very dry and the crop suffered from lack of water.

The yields of the three plots were, per acre, as follows:

	Plot 1	*Plot 2*	*Plot 3*
Cabbage pounds.........	13972	27020	18792
Value..................	$69.86	$135.10	$93.96

These results are just the reverse of the 1907 results, the high priced fertilizer giving an increase of $41 per acre over the low priced fertilizer.

Another piece of land that had been in field corn in 1906 was planted to apple trees in the spring of 1907. During that year various kinds of vegetables were planted between the trees, and no manure or fertilizer was used. The soil was a stiff clay loam. It was plowed early and the same low priced fertilizer that was put on plot 2 in 1907, was sown broadcast and harrowed in. The season was very dry, but the plants grew well without a check.

On part of this land several varieties of cabbage were planted and all of them made good heads. There were some signs of disease early in the season, but after the weather became dry this did not increase, and even the susceptible varieties like Danish Ball Head, made excellent heads.

The yield on this plot was at the rate of 35,332 pounds per acre valued at $176.61. This was a better yield than the sod land gave with the high priced fertilizer. It is most probable that had the season been wet, the sod land would have given best results and also that the low priced fertilizer may have been just as good. Thus it may be fair to conclude that from no especial brand of fertilizer can the same results be expected under all conditions of soil and seasons.

EXCESSIVE AMOUNTS OF PLANT FOOD USED ON SEED BEDS

It is the practice of growers of late cabbage in this section, to select a piece of poor light soil upon which to make their seed beds. This is given a very liberal dressing of commercial fertilizers. The plants produced are usually very wiry or woody, and tough, and withstand well the check incident to transplanting. The growers prefer a plant of this character to one that is succulent and green.

The idea of this experiment was to notice the effect of the different fertilizers on the plants and also on the matured crop. It is the practice of some florists when wishing to produce extra fine heads of the cockscomb, to first stunt the plants in poor sandy soil, and then afterward plant them in very rich soil. In this way they secure very fine blooms.

Knowing that some fertilizers have a hardening effect so that woody tissue is producd, it was thought that experiments might indicate the proper materials to use.

For the first experiment, season of 1907, plots were laid off on fairly good soil and treated with the following amounts of fertilizer per acre.

		Pounds.
Plot No. 1	Nitrate of soda	450
Plot No. 2	Dissolved phosphate rock	450
	Dried blood	450
	Nitrate of soda	450
	Muriate of potash	300
Plot No. 3	Dissolved phosphate rock	900
Plot No. 4	Dried Blood	900

The fertilizers were raked in and the seed sown. The seed came up well and at planting time the plants on plot No. 1 were very dark green and dwarf. Those on plot No. 2 were good plants of a darker shade of green than normal. Those on plot No. 3 were not as dark green, but nearly as large as the others. Those on plot No. 4 were quite succulent and dark green in appearance. The season for planting was good and there was no appreciable difference with regard to the stand. All of the plants grew. At harvest time the only difference that could be seen was in the plants which had been treated in the seed bed with nitrate of soda; these, while not any larger than the others, had all headed well.

The same experiment with slight changes was made in the season of 1908. This time the plots received fertilizers per acre as follows:

		Pounds.
Plot No. 1.	Dissolved phosphate rock	900
	Muriate of potash	300
	Dried blood	750
Plot No. 2.	Dissolved phosphate rock	900
	Muriate of potash	300
Plot No. 3.	Dissolved phosphate rock	900
Plot No. 4.	Nitrate of soda	600

The work was done the same as last year. The plants on plot No. 1 were strong, vigorous plants. Those on plot No. 2 and No. 3 were paler green in color. Those on plot No. 4 were very dark green, the same as in 1907.

The plants were set on a part on the same piece of sod land upon which the high and low priced fertilizer experiment was tried. The yield in pounds per acre and the value are as follows:

	Pounds.	*Value.*
Plot No. 1	19360	$96.80
Plot No. 2	19844	99.44
Plot No. 3	17364	86.82
Plot No. 4	23252	116.25

The results were in favor of the plants from seed beds receiving nitrate of soda, and as this was also true the year before, it seems as though it would pay to use nitrate of soda on the plant beds.

TESTING OF VARIETIES

The work with varieties commenced in 1903. The names and average weight in pounds and ounces per head are as follows:

Season 1903.

Variety	*lbs.*	*ozs.*	*Remarks*
Maule Midsummer	2	6	The best general appearance was made by Thorburns Large Late Drumhead, with Succession next. The Houser and Illinois Winter Market stood the best and gave the largest gross yield. These varieties have purplish green leaves somewhat crinkled and curled. Autumn King is similar in type, but made larger heads. Lupton, Danish Roundhead and Marblehead Mammoth suffered so severely from black rot as to be almost a failure.
Thorburn Large Late Drumhead	6	2	
Houser	3	2	
Lupton	1	12	
Marblehead Mammoth	1	13	
Danish Round Head	1	1	
Succession	3	2	
Livingston Ideal Winter	4	3	
Illinois Winter Market	3	1	
Stonemason Drum-Head	3	0	
Thorburn Autumn King	6	0	
Thorburn colossal	4	5	
Surehead	3	12	

Season 1904.

	Remarks
Autumn King	Many of these although headed, had rotten leaves, but compared favorably with other varieties.
Dreer Select Flat Dutch	Poor, made very little growth.
Salzer Hundred Weight	No better than Dreer Select Flat Dutch.
Salzer Kraut King	A little better than Salzer Hundred Weight
Short Stem Drumhead	Not quite as good as Salzer Kraut King.
Livingston Drumhead	About like Short Stem Drumhead.
Salzer Giant Flat Dutch	Fair growth, some disease.
Illinois Winter Market	Very good, purplish green crinkled leaves. No Disease.
Large Late Drumhead	Very poor.
Burpee Surehead	A good growth, similar to Illinois Winter Market. No disease or rot.
Bloomsdale Large Late Flat Dutch	A good growth. Disease resistant type like Surehead and Illinois Winter Market.
Burpee Safe Crop	Very fair. Apparently the best of the smooth leaved, whitish green sorts.

Variety	*Remarks*
Acme Flat Dutch	Very poor and much rotted.
The Lupton	Very poor and much diseased.
Danish Roundhead	Not Good.
Succession	Very poor.
Premium Flat Dutch	Very poor.

The season of 1904 was wet. The above varieties were planted on the rich spongy piece of land used for Experiment No. 1.

Season 1905. The varieties of cabbage were planted on same piece of land used in 1904. The season was wet.

Variety	*Remarks*
Landreth Market Gardener Large Late Flat Dutch	Doing very well, some good heads.
Illinois Winter Market	Good growth.
Autumn King	Very good.
Houser	Doing very well.
Succession	Suffered badly with disease.
Volga	All died.
French Varieties	
Milan d'St. Jean	Savoy type, all dead.
Milan d'Aubervilliers	Savoy type, many died, some fair heads.
Milan Gros d'Vertres	Savoy type, all dead.
Milan d'Pontoise	Savoy type, many dead. No good heads.
Milan d' Nouvege	Savoy Type, some dead. No good heads.
Chou d'Schweinfur	Whitish green type. No good heads,
Chou d'St. Dennis	Whitish green type, all dead.
Chou d'Vaugirard	Whitish green type, all dead,
Chou Quintal d'Auvergne	Whitish green type, many dead, no good heads.

Season 1907. The varieties were planted on a piece of sod land plowed early in the spring.

Variety	*Remarks*
Landreth Market Gardener Large Late Flat Dutch	Very vigorous healthy growth.
Burpee Surehead	Is similar to Landreth Large Late Flat Dutch.
Landreth Autumn King	Is similar to Landreth Flat Dutch.
Bolgiano Extra Large Late Flat Dutch	Whitish green type. Plants have lost nearly all lower leaves. Some good heads. See figure 1.
Wood Prize Head Flat Dutch	Better than Bolgiano, but not as good as Landreth Flat Dutch.

Variety	*Remarks*
Bumcombe North Carolina Winter	Very similar to Wood Flat Dutch.
Harris Perfection Late Winter	Very similar to Wood Flat Dutch.
Landreth Frost Proof Large Drumhead	Very similar in type to Landreth Flat Dutch, but heads are not quite as large.
Danish Round Head	Small round heads, not vigorous.
Bronxa	Similar to Danish Round Head.
Bolgo	Whitish green Flat Dutch type, not vigorous.
Gabourowka	Whitish green Flat Dutch type.
Danish Succession	Very much like Henderson Succession.
Geogia Collards	Vigorous growth with large green leaves, do not form heads.
Green Glased	Good growth, not much affected by worms but made no good heads.

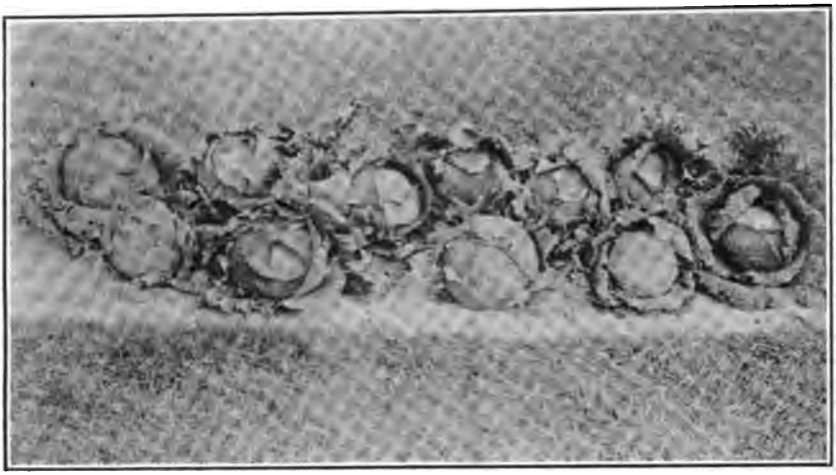


Fig. 2 Varieties of cabbage. 1—Perfection Savoy. 2—Drumhead Savoy. 3—Landreth Market Gardener Large Late Flat Dutch. 4—North Carolina Buncombe. 5—Bolgiano Large Late Flat Dutch. 6—Haines Perfection Late Beauty. 7—Landreth Frost-Proof Drumhead. 8—White Wonder. 9—Burpee Surehead. 10—Wood's Prize Head Flat Dutch. 11—Autumn King.

In order to get some notes on the resistance of the above varieties to frost, they were left in the field until December 16. There had been several severe frosts before that date. All the varieties with the exception of the Georgia Collard, Landreth Market Gardeners Large Late Flat Dutch, and Autumn Giant, suffered severely.

Some of the Landreth Market Gardeners Large Late Flat Dutch were left in the field during the winter and were sufficiently hardy to resist the frost and retained enough vitality to shoot to seed in the spring.

Season of 1908. The varieties of cabbage were planted on three different pieces of land. The first was a piece of sod land. The second was land that had been under cultivation in field crops for several years, and the third was the same piece that had been used in the investigations of diseases for several years past. The plants on the first piece all grew well and made good heads, but suffered severely from drouth. There was no black rot of any account among them. The second piece of land produced the best crop and all varieties made good heads. In fact it was the best crop of cabbage of all varieties that had been grown at the experiment station for ten years. A little of the black rot disease started, but disappeared as soon as the weather got dry.

On the third piece of land the cabbage did not do as well, although better this season than ever before. The weaker varieties like Danish Ball Head and others of the whitish green type, were considerably diseased.

The following varieties were tested in 1908. The average weight per head is given.

	WEIGHT		
Variety	*lbs.*	*ozs.*	*Remarks*
Danish Ball Head	3	0	Round hard heads.
Summer Danish Ball	3	8	Flattish heads, deep green, quite solid.
Hollander, or Danish Ball Head	3	12	Round hard heads.
Brunswick Netted Savoy	3	8	Savoy type, strong grower
Brill Long Island second Early	7	0	Good, solid, medium size heads
Red Dutch	4	0	Purple, hard heads.
Landreth 100 day	5	4	Good, medium size.
Brill Nonsuch	7	12	Medium size, good solid heads.
Volga or Russian	6	0	Good heads, half pointed type.
Johnson Ever-Ready	5	8	Similar to Volga.
Burpee Short Stem Drumhead	4	8	Flat Dutch type, medium vigorous.
Marblehead Mammoth	7	4	Large Flat Dutch, whitish green type.
Bolgiano Premium Flat Dutch	7	0	Whitish green Flat Dutch type.
Landreth Market Gardeners Large Late Flat Dutch	5	8	Purplish green crinkled leaves, vigorous.
Wood Autumn King	.7	8	Similar to Marblehead Mammoth.

Variety	*lbs.*	*ozs.*	*Remarks*
Landreth Autumn King	5	8	Similar to Market Gardeners Large Late Flat Dutch.
Henderson Autumn King	5	0	Vigorous, whitish green.
Burpee Autumn King	5	0	Similar to Landreth Autumn King.
Landreth Surehead	5	0	Similar to Burpee Autumn King
Burpee Surehead	6	0	Much lighter green than Landreths Surehead.
Henderson Matchless Large Late Flat Dutch	8	4	Similar to Marblehead Mammoth.
Maule Prize Flat Dutch	9	0	Whitish green, medium vigorous.
Henderson Selected Large Late Flat Dutch	6	0	Not as vigorous as Henderson Matchless.
Henderson Succession	5	0	Uniform heading, medium size.

There appears to be great variability in the varieties of cabbage as purchased from the different seedsmen. For instance, Landreth Autumn King and Burpee Autumn King are of the purplish green type that are hardy and resistant, while Henderson Autumn King belongs to the whitish green type which contract black rot and other diseases very readily when the conditions favor their development. Wood & Sons Autumn King seems to be quite different, being much larger and similar to Marblehead Mammoth. Most of the varieties received from Landreth seem to have the purplish green crinkled leaves. It is probably this that makes them distinctive as the "Landreth" cabbage.

It is interesting to note that the varieties which are resistant to cold are also resistant to heat, moisture and disease germs. In the lower sections of Maryland where the seasons are liable to be wet and the nights hot, it will be well to plant for the late crop, varieties having the purplish green, crinkled and curled leaves.

CONCLUSIONS

Cabbage is subject to, and often dies from, stem rot, black rot, root rot and other diseases. The spores of these diseases are generally present in sufficient quantities to inoculate the crop and only need favorable conditions for development. If, then, something could be done so as to do away with any conditions favoring the development of these diseases, farmers could work with more assurance of a crop. That the conditions of soil and weather are important factors is evident from the foregoing work.

With a soil of the character described above, rich, spongy and full of humus, a crop could not be grown in a rainy season. It might be supposed that if such a soil were thoroughly drained it would insure a successful crop. This is doubtful, however, as such soils hold water like a sponge and water drains very slowly from a sponge, even if there is good opportunity for it to pass off below. This amount of water, however, is likely to dissolve and to hold in solution, enough soil salts to poison the roots of the plants. The roots being partly decayed cannot absorb sufficient water to supply the needs of the plants at this, the most trying season, of their growth. This causes a check in the growth, making favorable conditions for disease germs to enter.

During the three seasons in which cabbage could not be raised on the experiment plot, good crops were being grown on soil quite similar when considering the amount of sand, clay and silt in each. They were totally different, however, in their capacity to retain water.

To be able to grow cabbage successfully in this climate, in any season, the soil should be in such a condition that the water will pass through it as freely as it would through a piece of pumice stone or porous rock. As a general rule the poorer the soil the drier and more porous it is. Thus it is that on the comparatively poor farms better late cabbages are grown than in the market gardens that are very rich.

A sod field broken early in the spring and well manured has generally been found to grow the best cabbage. This does not apply to the early crops; these do best on the soils that are rich and full of humus.

Low priced fertilizers sometimes give as good results as the higher priced goods, but on the whole it will pay to be liberal with nitrogen. The two experiments indicate that it is profitable to use nitrate of soda on the plant beds, at the rate of 450 to 600 pounds per acre.

In localities and on soils where cabbage diseases are prevalent, it is safer to plant the type of cabbage with the purplish green crinkled leaves. Late cabbage does well on ordinary farm land.

The crop generally seems to do better if the field is marked off both ways and the plants are set in the check and the cultivation is level.

CULTURAL DIRECTIONS

Origin. The cabbage is a native of western and southern Europe and has been used for human food from time immemorial. All of the types of cabbage, cauliflower, Brussels sprouts, collard, and kale have sprung from the same original source, namely, *Brassica oleracea,* Linn. The wild type is still growing on the chalk cliffs of the English Channel.

On the cliffs of southeastern England is now found a plant similar to the Georgia collards.

Types. There are three distinct types of cabbage with reference to the shape of the head, namely, round, oval and flat. Some varieties are distinct in type while others partake of two or more shapes due to crossing in seed production. There is much variation in the shape, color, character and texture of the leaf, ranging from regular straight edges, almost white, smooth and tender, to irregular almost fringed edges, dark purple color and coarse, tough texture.

Generally speaking all varieties are hardy, but there is some variation in hardiness. Usually the purplish-green varieties with crinkled and fringed leaves are hardier than the whitish-green sorts with smooth, regular leaves. The cold resisting varieties are also the most heat resisting.

Propagation. For a very early crop the seed may be sown in a well prepared seed bed outside in September and the plants be wintered over in a cold frame or by mulching with straw in a sheltered place. These plants may be set out very early in spring, long before spring grown plants may be used.

For early crops from spring grown plants, the seed is sown in the hot beds or greenhouse in February or March, that is, about four or six weeks before the plants may be set out of doors. To make extra good plants they will need to be taken from the seed bed and be pricked out two inches apart in other beds.

For late crops the seed is sown in beds outside the latter part of May. When pulled the roots should be dipped in thin mud to keep them moist until they are planted.

By setting a succession of plants the crop may be constant from May or June until Christmas.

Field culture. The plants of early varieties are set out in spring as early as the weather permits, in rows three feet apart and two feet apart in the rows. The fall grown plants are often planted in the field in November. Furrows are turned where the rows are to be and the plants are set low in the furrows so as to be protected. North and south furrows with plants set on the east side are satisfactory, although east and west furrows are sometimes preferred. The plants are set one foot apart because some are likely to run up to seed and become worthless. These should be destroyed.

Later varieties require more room. Early plants must be set deep, that is, so the base of the leaves is below the ground. If freezing weather comes the plants may be covered with earth until danger from frost is over.

Sometimes the seed is sown where the plants are to grow. Mark out the rows both ways and plant seven or eight seeds in each hill. When three or four inches high take out all but one plant.

Cultivation must be done thoroughly and often, for the cabbage is a gross feeder and needs plenty of moisture. A cultivator with fine teeth is most desirable.

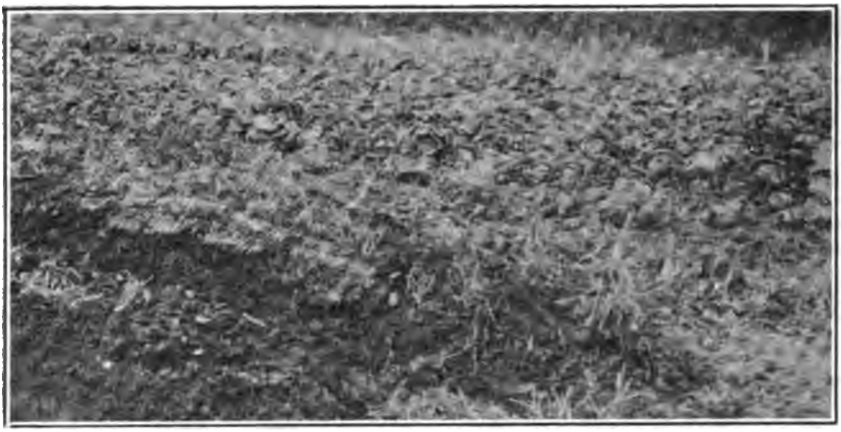
Soil. The early varieties do best on a good sandy loam which has been well manured for several years. The lighter soils are also very good. Late cabbage does best on heavier loams.

Manures and Fertilizers. Well rotted manure is most suitable for early cabbage where a rapid growth is necessary. This may be supplemented by quick acting chemical fertilizers like nitrate of soda and dissolved rock, about 200 pounds of each per acre. The midseason crop does not want so much fertility, for the growth should not be pushed so fast. Late cabbage needs different treatment. It does best on sod land which has been given eight or ten tons of stable manure and is plowed very early in spring. Corn ground, with crimson clover for a cover crop, manured and plowed early in spring, is also good. If manure is not available the following amounts of fertilizer per acre may be broadcasted a short time before the plants are set: 240 pounds of dissolved rock, 400 pounds dried blood, 120 of nitrate of soda and 100 of muriate of potash. The fertilizer should be worked into the soil with a good harrow.

Harvesting. Early cabbage is cut and sold as soon as the heads are large enough. The loose leaves are taken from the head and it is ready for market.

With later cabbage only the ripe heads are put on the market at the time or soon after they are cut. The unripe and loose heads are pulled with stems and roots on and stored for winter or spring marketing. Some ripe or nearly ripe heads for winter use are also pulled with stems on for storing. See Fig. 3.

Storing Cabbage. There are two methods of storing cabbage, namely, "heads down" and "heads up". The former method includes the heads ripe or nearly so for winter use. Furrows are plowed and the loose earth thrown out. The cabbage is placed in the furrow with the heads down and earth is shoveled or plowed over the heads and stems so only the roots are uncovered. If heavy freezing is feared, straw or manure should be thrown over the ridges, for it is best not to let the heads freeze much if it can be avoided.



Fig, 3 Cabbage stored for winter, Heads down in front. Heads up at the rear.

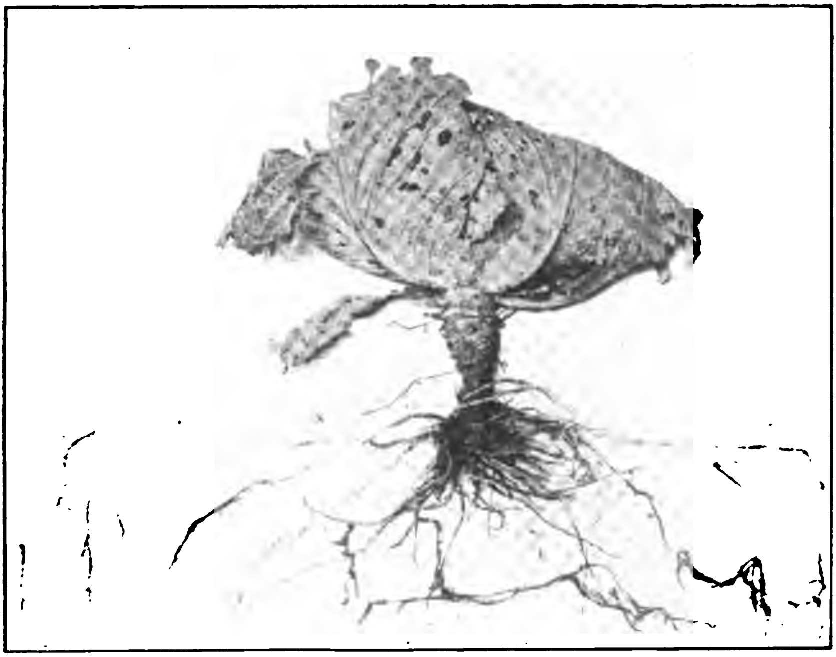


Fig 4, Showing root development of cabbage (roots were carefully washed out).

The unripe cabbage is stored "heads up" so that they may continue growing and developing. A furrow is plowed and the cabbage is set close together roots down in it, and earth is worked and tramped around the roots and stems. A second furrow is plowed throwing the earth on the stems of the first row. Beds six or eight rows wide may be made this way. Care must be taken that the stems are buried up to the heads, for hard freezing injures them. If properly stored the cabbage will continue to grow and will be in good condition for late winter or spring use. Pine boughs or some light material should be thrown over the beds to protect the heads from bright sunshine and harsh winds, but not enough need be used to protect from frost, as freezing does not injure the heads in this unripe condition.

Varieties. The very early kinds are generally of oval or oval pointed shape of which Early Jersey Wakefield is the most popular and satisfactory. Other good ones are Charleston Wakefield, Early York and Early Winningstadt. The very early flat-headed ones are small and not so satisfactory as the Wakefield type. A few of the good second early varieties are Early Spring, Early Flat Dutch and All-Head Early; these are of the Early Flat Dutch type.

For midseason crops the flat-headed varieties are the only ones used, Succession and All Seasons being among the best.

There are many good late varieties and it must be determined which will do best in any certain locality. In localities with a reasonable amount of moisture and hot sun, most of the late varieties do well. Varieties with fringed leaves of a bluish-green color seem to stand the vicissitudes of moisture, temperature and soil conditions better than other types. Some of these are Landreth Market Gardener, Large Late Flat Dutch, Landreth Surehead, Landreth Autumn King and Burpee Autumn King.

The late Flat Dutch varieties and strains come next in favor and reliability; they have light green colored leaves not fringed.

In some sections the Danish Ball Head is the most profitable late variety; it is used especially for making sauerkraut. It cannot stand heat and moisture.

The Savoy, or crumpled leaf varieties, are very sweet and delicious, but are not much grown. American Drumhead Savoy and Netted Savoy are good ones.

The red varieties are used somewhat for pickling and making slaw. The Red Dutch and Mammoth Rock Red are very good.

Seed Growing. The plants for seed growing should not have hard heads when they are pulled. They are stored "heads up" and covered with enough mulching material to protect from frost. About May 1, they are planted in rows four feet apart and three feet apart in the row. Seed stalks are sent up through the heads and as the seed pods turn yellow and ripen the stalks are cut and hung in an airy room to dry, after which the seed is thrashed out.

Cabbage stems will send up seed stalks and they are sometimes used, but seed so produced is considered inferior and this method should be discarded.

INSECTS

The cabbage maggot, *Pegomya brassicæ,* works on all plants of the cabbage or mustard family. Eggs are laid on the soil near the plants and the maggots crawl to the rootlets, upon which they feed, and then they burrow into the stem. There are two broods.

Remedy. A tarred paper card around the plant prevents the female from laying eggs near the plants and the maggots from reaching the roots. Crude carbolic acid, one pint emulsified in one gallon of water and then diluted to thirty gallons, is used around plants each week until May 15. Kerosene emulsion, 15 per cent, poured around plants is also beneficial.

The imported cabbage butterfly, *Poutia rapæ,* is one of the most common insects. It is the pale yellow butterfly hovering around mud holes, cabbage fields, etc. Eggs are laid on all plants of the mustard family and the caterpillars are ravenous feeders.

Remedy. Use Paris green, one pound, and lime, four pounds, in fifty gallons water until the heads are two-third grown or use Paris green in Bordeaux mixture. Spray as often as is necessary. Paris green may also be mixed with lime dust, road dust, land plaster and flour, and be sprinkled on the plants. Hellebore, one ounce to two gallons of water, should be used after the heads are two-thirds grown.

The cabbage plusia, *Autographa brassicæ,* works similarly to the insect above. The caterpillars are dark green with white stripes.

Remedy. See imported cabbage butterfly.

The zebra caterpillar, *Mamestra trifolii,* is distinguished by a pinkish stripe along each side. They eat the leaves and bore into the heads and stems at night and hide under clods of earth or stones during the day.

Remedy. Same as above.

The harlequin cabbage bug, *Murgantis histrionica,* is very destructive at times and attacks all plants of the mustard family and almost everything else green when this supply gives out. It is bright red with yellow or black mottling and sucks its food from the plants.

Remedy. Plant trap crops such as kale or mustard in the cabbage, cauliflower or other crop in this family, and the bugs will go to the trap crops, where they may be sprayed and killed with pure kerosene. These trap crops should be planted late as well as early.

Clean cultivation and the destruction of weeds and rubbish tend to reduce the numbers of this bug.

DISEASES

The black rot, *Pseudomonas campestris,* shows first by darkening the leaf veins. It causes one-sided, dwarfed or rotten heads.

Remedy. No reliable remedy is known. The seeds may be soaked for fifteen minutes in a solution of formalin, 1 part to 250 of water, or in a solution of corrosive sublimate, 1 part to 1000 parts of water.

Use only strong healthy plants and land well drained and not infested. Destroy diseased plants.

The club root or club foot, *Plasmodiophora brassicæ,* causes the roots and stems to become swollen and distorted. The other plants in the cabbage family are similarly affected and the fungus lives on such weeds as mustard, shepherd's purse, peppergrass, etc.

Remedy. Do not use ground once infested as the disease spores live in the soil many years. Use clean, well drained soil. Apply 75 bushels of fresh stone lime per acre on infested ground plowed in the fall, work the lime into the ground. Destroy diseased plants.

The wilt, *Fusarium sp.,* is caused by a fungus which attacks the roots causing the leaves to wilt and drop. The disease spores live in the ground.

Remedy. Destroy diseased plants and use land not infested with this disease. No good remedy is known.

The downy mildew, *Peronospora parasitica,* is sometimes present on plants in the seed bed, but may appear on the outer leaves of older plants.

Remedy. In the seed bed use less water and spray with Bordeaux. In the field use Bordeaux.

The soft rot is a bacterial disease which usually follows the fungous diseases mentioned and causes the heads to rot and become foul smelling.

These diseases attack other plants in the cabbage family and are combated as mentioned above.

THE CHEMICAL COMPOSITION OF THE CABBAGE PLANT

By H. J. Patterson

As the cabbage crop is of considerable commercial importance to Maryland and many questions were asked from time to time as to the relation of the crop to soil exhaustion, and the value of the refuse portions both for feeding and fertilizing purposes, it was thought desirable to make a fairly complete chemical study of the crop.

The analyses reported herewith were made in 1893, and they have awaited the publication of a bulletin on this crop. The samples analyzed represent a number of average mature plants, or plants with heads which are in the best condition for market.

The results of the chemical analysis are given in the following tables:

Dry Matter and Principal Mineral Constituents of Different Parts of the Mature Cabbage Plant

COMPONENTS.	HEADS.		REFUSE, LEAVES AND STALK.		ROOT.	
	Per cent.	Yield per acre pounds.	Per cent.	Yield per acre pounds.	Per cent.	Yield per acre pounds.
Water	98.50	13790	91.02	8191.8	83.29	937.0
Dry matter	1.50	210	8.98	808.2	16.71	188.0
Total	100.00	14000	100.00	9000.0	100.00	1125.0
Organic matter	1.29	180.6	5.40	486.0	14.21	159.9
Mineral matter	0.21	29.4	3.58	322.2	2.50	28.1
Dry matter	1.50	210.0	8.98	808.2	16.71	188.0
Pure ash	0.20	28.0	1.58	142.2	1.53	17.2
Sand	0.01	1.4	2.00	180.0	0.97	10.9
Crude ash	0.21	29.4	3.58	322.2	2.50	28.1
Lime (CaO)	0.019	2.7	0.441	39.7	0.107	1.2
Magnesia (MgO)	0.005	0.7	0.060	5.4	0.057	0.6
Phosphoric acid	0.023	3.2	0.080	7.2	0.111	1.2
Potash (K_2O)	0.087	12.2	0.402	36.2	0.762	8.6
Soda (Na_2O)	0.001	0.1	0.052	4.7	0.082	0.9
Iron and Aluminum	0.031	4.3	0.021	1.9	0.025	0.3
Chlorine	0.010	1.4	0.018	1.6	0.075	0.8
Sulphur (SO_3)	0.056	7.8	0.035	2.8	0.030	0.3
Sand	0.010	1.4	2.000	180.0	0.97	1.0
Nitrogen	0.065	9.1	0.227	20.4	0.352	4.0

Food Constituents in Heads and Refuse Cabbage

	HEADS.		REFUSE MATTER.	
	Per cent.	Yield per acre.	Per cent.	Yield per acre.
Water	98.50	13790.0	91.02	8191.8
Ash	0.21	29.4	3.58	322.2
Protein	0.41	57.4	1.42	127.8
Crude fiber	0.38	53.2	1.32	118.8
Nitrogen-free extract	0.46	64.4	2.41	216.9
Fat	0.04	5.6	0.25	22.5
Total	100.00	14000.0	100.00	9000.0

These results would indicate that cabbage is a very watery food and contains little dry matter, but that the relative amount of protein in the dry matter would class it as relatively more nutritious than is usually recognized.

Statistics of the eleventh census show that there are over 77,000 acres devoted to the growing of cabbage in the United States and about 4,000 acres in Maryland. Each acre of cabbage costs on the average $21 for labor and cultivation and gives a net profit of $118. The same statistics also state that there is on the average $33 worth of fertilizers applied to each acre of cabbage.

The results in the above tables show the different fertilizing elements found in the various parts of the cabbage plant to be as follows:

Fertilizing Material Found in the Different Parts of Cabbage Plants.
(Per cents in fresh materials.)

	HEADS	REFUSE LEAVES	ROOT
	Per cent	*Per cent*	*Per cent*
Phosphoric acid	0.023	0.080	0.111
Potash	0.087	0.402	0.762
Nitrogen	0.065	0.227	0.352
Lime	0.019	0.441	0.107

An average crop of cabbage will yield per acre 4000 mature heads weighing 3½ pounds each, or 14,000 pounds.

The refuse matter from the 4000 mature heads and 500 unmatured plants, averaging 2 pounds each, will yield 9000 pounds of matter per acre. The 4500 roots, averaging ¼ pound each, will allow 1125 pounds of vegetable matter to remain in the land.

Combining the above figures we find that each acre of an average crop of cabbage requires during its growth the following amounts of plant food:

Pounds of Fertilizer found in Cabbage from one Acre

	HEADS *Pounds*	REFUSE *Pounds*	ROOTS *Pounds*	TOTAL *Pounds*
Phosphoric acid	3.2	7.2	1.2	11.6
Potash	12.2	36.2	8.6	57.0
Nitrogen	9.1	20.4	4.0	33.5

This means that the cabbage crop of the United States requires in its growth at least 450 tons of phosphoric acid (P_2O_5), 2195 tons of potash (K_2O), and 1290 tons of nitrogen (N); of these amounts 123 tons of phosphoric acid, 470 tons of potash and 350 tons of nitrogen are sold off the farms in the heads. The balance is left on the land as refuse, either to be fed to stock or plowed under for a succeeding crop.

To replace the amount sold off the land in the heads it would require an equivalent of about the following amount of commercial fertilizers:

870 tons of phosphate rock of 14 per cent grade, 940 tons of muriate of potash of 85 per cent purity, 2100 tons of nitrate of soda of 95 per cent purity.

Or in other words it would require about 4000 tons of a fertilizer analyzing:

3 per cent phosphoric acid,
12 per cent potash,
9 per cent nitrogen,

to replace the plant foods sold in the heads. Of these amounts over 50 per cent would be needed in the vicinity of New York and Philadelphia, 6 per cent in Maryland and 13 per cent in the Norfolk truck section. But in feeding a crop there must be available plant food in proportion to the amounts needed in the entire plant without reference to that which is found in the edible or marketable portion. These proportions would be 3 per cent phosphoric acid, 14 per cent of potash and 8 per cent of nitrogen.

The proportions of plant food necessary to be furnished in a commercial fertilizer must always be modified with reference to the soil to which it is to be applied, and while it is but rarely desirable to maintain the above proportions, yet taking the average soils used for cabbage culture, it will be found that most of the so-called truck and cabbage fertilizer on the market contain entirely too little potash and nitrogen in proportion to the phosphoric acid. With a crop like cabbage it is desirable to grow it quickly and to keep it growing to ensure a good quality, and to do this there must be plenty of available plant food constantly at hand.

THE MARYLAND
Agricultural Experiment Station

BULLETIN No. 134 APRIL, 1909

BROWN TAIL MOTH, HOUSE FLY AND MOSQUITO

BY THOS. B. SYMONS

INTRODUCTION

In view of the fact that the overwintering nests of the notorious brown-tail moth have been found on trees and plants imported into this State during the past few months and because of the extreme likelihood of its escape, it is deemed wise to give the public a brief description of the insect in order that its establishment, if such is accidentally accomplished during the coming season, may be more readily detected and immediate steps taken towards extermination.

The comparatively recent awakening of the public mind to a realisation of the important rôle that insects play in disseminating some of our most common and virulent diseases suggests a brief discussion of one of our most common household pests, the common house fly or, as Dr. Howard fittingly designates it, "typhoid fly." Good health is the greatest asset of which any locality can boast, and it is with a view of suggesting better sanitary conditions around the farm and home looking towards a decrease in the abundance of this pest that a brief discussion of this insect is here given.

During the summer of 1904 this department commenced an investigation of the mosquito pest in Maryland. For the want of funds the work has not been continued as was anticipated, although observations and collections have been made in different parts of the State during the past four years as opportunity afforded. While the State has not seen fit to appropriate money for a thorough investigation of the problem, yet it is possible for much good to be accomplished by individual effort in the control of the pest. Inasmuch as bulletin No. 109 issued in May 1906 is now out of print it is thought desirable to again call the attention of the people of the State to the importance of the problem as a whole and particularly to the control of the common house mosquito.

This bulletin therefore may well be considered as a word of warning to the people of Maryland to prevent the establishment of the brown-tail moth in the State and as far as possible prevent diseases being disseminated by the house fly and mosquito.

The writer disclaims any originality for the contents of this bulletin as for the most part the description of the insects herein mentioned are a compilation from various writers, particularly as regards the discussion of the brown-tail moth

BROWN-TAIL MOTH

(*Euproctis chrysorrhœa*)

This is one of the oldest caterpillar pests of Europe and it is very strange that a general importation of the nests such as has occurred during the past winter has not occurred heretofore.

This European pest according to Howard was first observed in this country in Massachsuetts in the early nineties, being probably imported upon some rose stock. From its introduction to 1898, according to Sanderson, no direct effort was made by the State to retard its spread, although the legislature had passed a law requiring local authorities to suppress the insect. In 1898 an appropriation of $10,000 from the gypsy moth funds was made to the Massachusetts Board of Agriculture, to suppress the brown-tail moth. From 1900 to 1904 no concerted effort through State funds was made against the gypsy and brown-tail moths in Massachusetts. Individual effort by local towns and private parties met with only partial success. During this interval the two pests gained a tremendous headway and it was necessary for the State of Massachusests through its legislature of 1905 to appropriate $150,000 per annum to aid in the control of the gypsy and brown-tail moths. The following legislature 1906 increased the appropriation to $225,000. On account of the habits of the two moths, the brown-tail spreads more rapidly than the gypsy moth and at the present time, therefore, the former covers a more extended territory in New England than the latter. At this writing there are approximately $500,000 appropriated by the United States Government and the States of Massachusetts, New Hampshire, Connecticut, Maine and Rhode Island for work in the suppression of these two insects. In addition the enormous expense to towns, villages and private individuals through their effort to protect their property and the loss of timber and the depreciation of real estate will bring the cost of the insects in New England states already into millions of dollars. It therefore behooves every one in this State to spare no means to prevent their establishment in Maryland.

Description and Life History

There is but one generation of the brown-tail moth annually in New England. The insect winters as a tiny larva or caterpillar within a web or nest made of silk and leaves woven together tightly. The nests will vary in size usually from three to four inches in length and will contain two hundred or more caterpillars (see Figs. I and II).

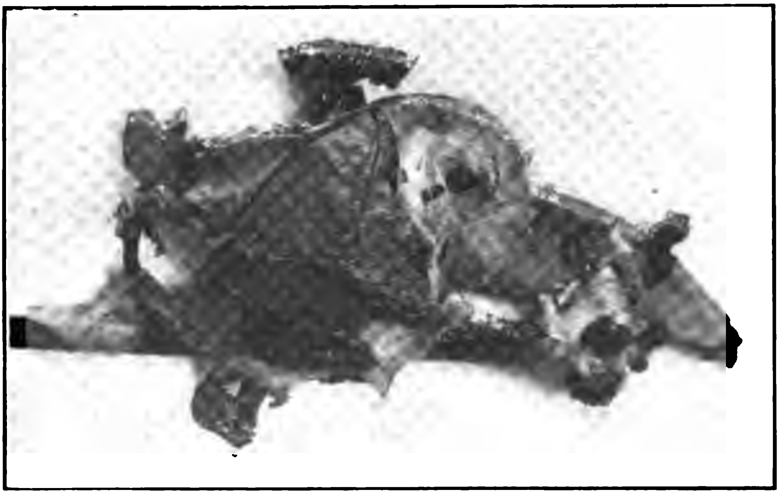


Fig. 1 Nest of the brown-tail moth taken from an oak tree in Massachusetts. Photograph by L. M. Peairs.

These nests are securely attached to the tips of trees or plants on which the caterpillars were working before hibernation.

In early spring, as soon as the buds of fruit and shade trees appear, according to Howard, these one-fourth grown caterpillars emerge from their winter quarters and immediately commence feeding upon the buds and blossoms and later the foliage. The young caterpillar is of a

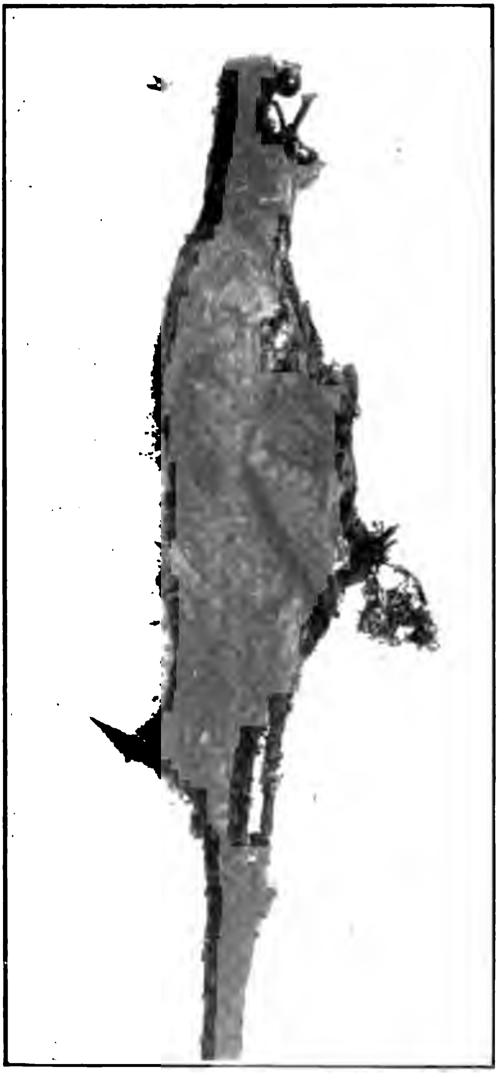


Fig. 2 A characteristic nest of the brown-tail moth found on imported stock in Maryland. Photograph by L. M. Peairs.

blackish color and covered with very small hairs. The full-grown larva is about two inches long, reddish brown in color, with a broken white stripe on each side and two red dots in the back near the hind end. The body is covered with numerous tubercles bearing long barbed hairs. The tubercles along the back and sides of the abdomen are thickly covered with short brown hairs in addition to the long ones.

The full-grown larva changes to a pupa within a cocoon which it previously makes with silk and leaves. According to Howard these cocoons may be in groups or singly in some secluded spots or at the tips of branches of trees on which they have fed. The cocoon is so loosely made that the pupa may be seen through it. According to Sanderson the pupa stage lasts about twenty days, the adult moths emerging in the early part of July.

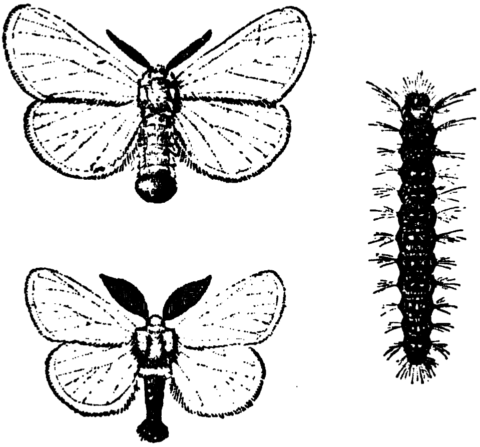


Fig. 3 The brown-tail moth (*Euproctis chrysorrhœa*); Female moth above male moth below, larva or caterpillar at right, slightly enlarged; after "oward Farmers' Bulletin, No. 264, United States Department of Agriculture.

The moths of both sexes are pure white with the exception of the abdomen, which is dark brown (see Fig. 3). The tip of the abdomen of both sexes, more pronounced in the female, bears a small tuft of brown hairs, from which the insect gets its name. The female moth has an expanse of about one and one-half inches while the male is somewhat smaller. The moths are strong fliers and are readily attracted to lights.

Howard states that the moths commence laying eggs usually on the underside of leaves toward the tips of the limbs soon after emerging. The eggs hatch in about three weeks. The young caterpillars feed upon the surface of the leaves, skeletonizing them and when abundant causing the foliage to turn brown as if blighted or scorched by fire.

In early fall the young larvæ commence spinning their nests within which they pass the winter.

Means of Distribution and Food Plants

According to the various writers the principal spread takes place through the flight of the moths just after emergence. This occurs in the night as the moths are seldom seen flying in the day time. The fact that the moth is a strong flier accounts for its greater spread in the New England states than the gypsy moth. The direction and force of the wind at the time of flight will to a great extent determine the spread of the pest.

In addition to its power of flight the insect in its larva or caterpillar state can, of course, be distributed by various means. Especially is this possible in the transporting of trees and plants which contain the over-wintering nests of the insect.

The injury caused by this insect where established can be hardly estimated in terms of dollars and cents. The foliage of all fruit trees, especially pear and apple where available, seems to be the preferred food of the caterpillars, but they freely attack all shade trees including the oaks, maples, elm and the like, in fact Sanderson states that all fruit, shade and forest trees may be attacked with the exception of pines, spruces and other conifers. Fernald and Kirkland published in 1903 a list of eighty different food plants of this pest. This extensive range of food plants shows the possibilities of severe damage to our trees and shrubs if its establishment is accomplished. It is possible that the pest might be even more destructive in the south than it is now in the New England states.

Brown-Tail Rash

In addition to the severe injury that this pest will occasion to fruit, shade and forest trees, and the consequent enormous cost of fighting it, there is another feature connected with its presence that is very troublesome if not alarming, that is, danger to the health of people.

As mentioned in the description of the insect, the larva or caterpillar bears tiny hairs which are barbed as shown in Fig. 4. When the caterpillars molt these barbed hairs are shed with the skin. Upon drying, these skins and hairs float about in the air and are a source of constant trouble to persons living in an infested district. When the caterpillars' skins, or even loose hairs, come in contact with the skin they cause a severe irritation. Howard states "that a large part of the popular feeling in New England that the brown-tail moth must be exterminated is due quite as much to the prevalence and annoyance of this rash as to the loss of vegetation from the work of the caterpillar."

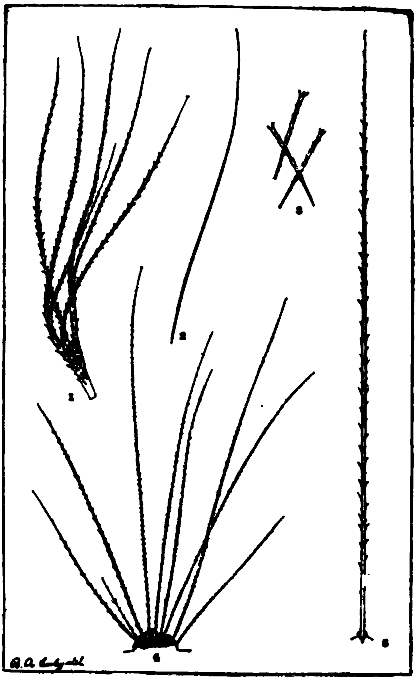


Fig. 4 Various forms of hairs from brown-tail moth caterpillar. (After Fernald and Kirkland. Through courtesy of Sanderson.)

Work in Maryland

The first intimation that the brown-tail moth nests were being found on imported nursery stock came through Mr. Geo. G. Atwood, Chief, Bureau Horticulture, Board of Agriculture of New York, who reported the finding of the nests on stock imported from France. Acting immediately upon these advices, the nurserymen of the State were requested to hold unopened all imported shipments of seedlings or other stock received until the arrival of a representative of this department at the nursery in order that all the stock could be carefully inspected. It is pleasing to acknowledge the hearty coöperation of all the nurserymen of this State with the department in our efforts to prevent the escape of a single nest.

In all about 1,150,000 seedlings and other stock have been carefully inspected and a total of 700 nests of the brown-tail moth have been found and burned. This will give an idea of the extra amount of work that was forced on this department whose funds for even the regular amount of work are very limited. However, no pains could be spared to prevent the escape of the pest in the State. That we have been entirely successful is by no means certain. For in the examination of such a large amount of stock and with the possibility of individual ship-

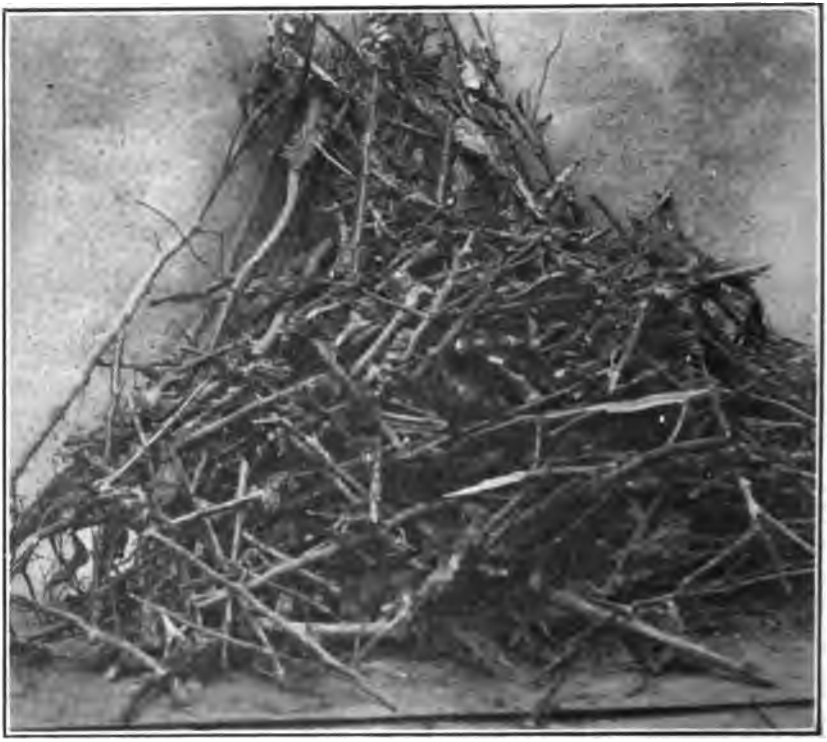


Fig. 5 A mass of imported trees and seedlings showing numerous nests of the brown-tail moth attached. Photograph by L. M. Peairs.

ments arriving of which we have no knowledge, there is indeed a strong possibility of an outbreak of the pest some place in the State during the coming season. It is for this reason that this discussion of the pest is brought before the people in order that all may be on the lookout for its first appearance in the larva stage.

Remedies

With this as with other insect pests whose life histories are understood we can attack it at its weakest point. With this pest undoubtedly the easiest and practically the only effective means of artifical control where established is by cutting off the over-wintering nests during the late fall, winter or early spring and destroying the tiny larvæ within. This of course can be supplemented by spraying with an arsenical mixture, when the larvæ appear on the foliage in spring. When young, according to Howard, the larvæ may be killed with the ordinary strength of paris green or arsenic of lead, but when the larvæ are half grown or larger, according to Sanderson, 5 pounds of arsenate of lead to 50 gallons of water is necessary to prove effective.

If it should happen that the pest appears in any locality of this State during this or succeeding years, it will be the duty of the State authorities, in coöperation with private individuals, to spare no means in immediately undertaking to exterminate it.

It is hoped that the people of the State will keep a sharp lookout for the first appearance of a strange caterpillar that may be devouring foliage of any kind of tree and upon its detection immediately notify the State authorities in charge of such work.

DISEASE-CARRYING INSECTS

The important rôle that insects play in the dissemination of disease has only during comparatively recent years been appreciated by the public. The popular feeling towards house flies and mosquitoes has too long been simply that they are inevitable nuisances which must be put up with. Their effect upon the health of a community has not been questioned or considered. But, now that we have any quantity of proof of the ability of these pests to transmit or disseminate some of our most common diseases, we are able to explain many unanswered questions as to the source of infection of numerous outbreaks of these diseases. Further study of this subject will no doubt bring to light much additional information in regard to the ability of many of our common pests other than those mentioned above to disseminate or transmit disease among human beings.

THE TYPHOID OR COMMON HOUSE FLY

(*Musca domestica*)

The change of the name of this the most common of all household pests from "house fly" to "typhoid fly," as suggested by Dr. L. O. Howard in Bulletin 78 of the United States Department of Agriculture, is considered very appropriate and desirable, inasmuch as it is established by abundant evidence that this pest is now largely responsible for the spread of that dreaded disease "typhoid fever." It is well known that the germ of typhoid fever may be in the human system several weeks before it is detected and also for several weeks after all symptoms have disappeared and the patient apparently well. The excreta of such persons which may be in an open privy, or in many cases in country districts located anywhere around the outbuildings, is visited by the fly, whose feet and body are particularly adapted to carrying germs. This same fly after visiting such places may immediately return to the house of the sick or that of a neighbor and be seen crawling in the kitchen or dining room over the food that is prepared to be eaten by the unaffected persons. Not only may the fly disseminate the disease to the healthy within the family of the sick or that of close-by neighbors, but there is every opportunity for the same infected fly to visit the village or city store where foods are exposed and thus spread the disease to those families who purchase them. The butcher wagon of the country or the trolley or express train carrying food such as sacked meat, etc., may easily become factors in the dissemination of this disease if such carriers are loaded at or visit points where conditions are favorable for visitation by infested flies. The house fly is connected with the dissemination of intestinal diseases other than typhoid fever. Dr. Jackson of New York points out that the immunity from diarrhea of breast-fed babies and the frequency of its occurrence among artificially fed babies indicates strongly the food as a medium of transmission, and further states that in his extended study of this problem along the water front of New York City during 1907 he found that the prevalence of these diseases among children and adults corresponded to the prevalence of flies. Further Dr. Felt in a recent paper states that "It is well known that flies feed upon sputum. Experiments by Lord recorded in the Boston Medical and Surgical Journal show that flies may inject tubercular sputum and excrete tubercular bacilli, the virulence of which may last for at least fifteen days. He considers the danger of human infection from this source to lie in the injection of fly specks on food, and suggests that during the fly season great attention should be paid to the screening of rooms and hospital wards containing patients with tuberculosis and laboratories where tubercular material is examined."

In Bulletin No. 78 of the Bureau of Entomology, United States Department of Agriculture, which should be read by every person in the State, Dr. Howard cites among other interesting data that Dr. G. N. Rober estimates that the decrease in the vital assets of the country through typhoid fever in a single year is more than $350,000,000.00. Dr. Howard says that the house fly as an important agent in the spread of this disease is responsible for a considerable portion of this decrease in the vital assets As an agency in the spread of other intestinal diseases it must be charged with a great addition to this sum. Yet it is allowed to breed unrestricted all over the United States.

While the house fly cannot of course be charged exclusively with the dissemination of such intestinal diseases, the writer fully believes that no single factor aids in their spread during the fly season to a greater extent than this common pest of mankind.

Further than this the house fly is a vexatious nuisance in itself. Its presence in a house causes additional cleaning to paint work, walls, pictures, etc., as well as being a continual nuisance to the inhabitants whether asleep or awake in the day time. Dr. Howard estimates that "The house fly with mosquitoes necessitates an annual outlay for window and door screens in the United States of not less than ten millions of dollars." Even this amount is comparatively nothing to what should be spent for this purpose without there is and what we hope will be in the near future a united campaign conducted by the people in preventing the pest from reproducing. This then suggests the life history of the insect and how it can be combated.

Description and Life History

The common house fly (*Musca domestica*) is a medium sized fly, grayish in color with its body somewhat streaked with blackish gray. As previously mentioned, its body, but more especially its legs and feet are covered with minute hairs. Its mouth parts are formed for lapping and not biting, yet many people think of the house fly as being able to bite. This is no doubt due to the presence in the houses of one of the

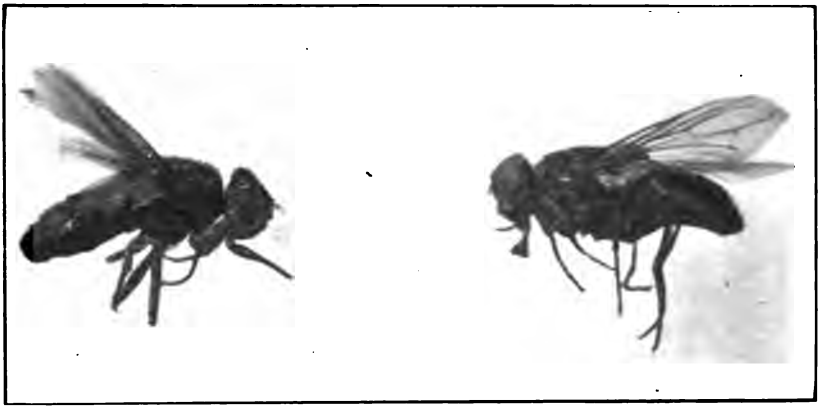


Fig. 6 House fly to the right, showing lapping mouth parts. Stable fly to the left showing piercing mouth parts. Enlarged. Photograph by L. M. Peairs.

stable flies whose mouth parts are formed for piercing. Fig. 6 illustrates the mouth parts of these flies.

The insect winters in the adult state, hiding in houses or other out-of-the-way places. At the approach of warm weather the flies come forth from their hiding places and commence to lay their tiny white eggs. These eggs commonly are deposited in horse manure as this seems to be the preferred larval food and it is from this source that

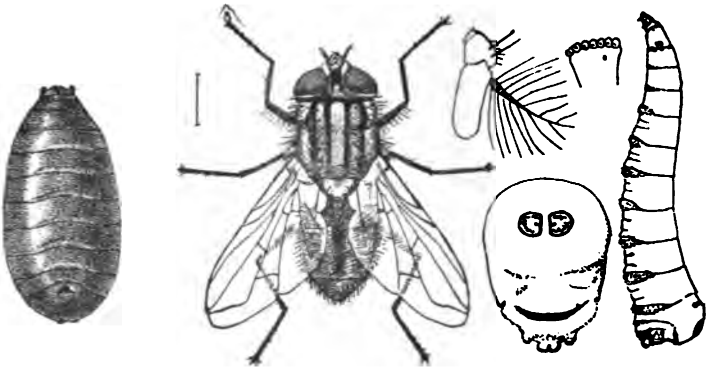


Fig. 7 The typhoid or common house fly (*Musca domestica*). Puparium at left; adult next with enlarged antenna, larva and enlarged parts at right. Enlarged after Howard, Bulletin No. 30, New Series, Division Entomology, United States Department of Agriculture.

the majority of the house flies come. Eggs may also be laid in human excreta and in decayed vegetable and animal matter.

Dr. Howard found in midsummer in the vicinity of Washington that a female fly lays about 120 eggs which hatch in about eight hours. The white larvæ or maggots which are pointed at one end and blunt at the other grow rapidly and change to a pupa in four or five days, the adult emerging from the pupa in about five days, thus completing their life history in about ten days. Fig. 7 shows the different stages of the insect and Fig. 8 shows a number of larvæ or maggots in a pile of horse manure. Howard states that "there is abundance of time for

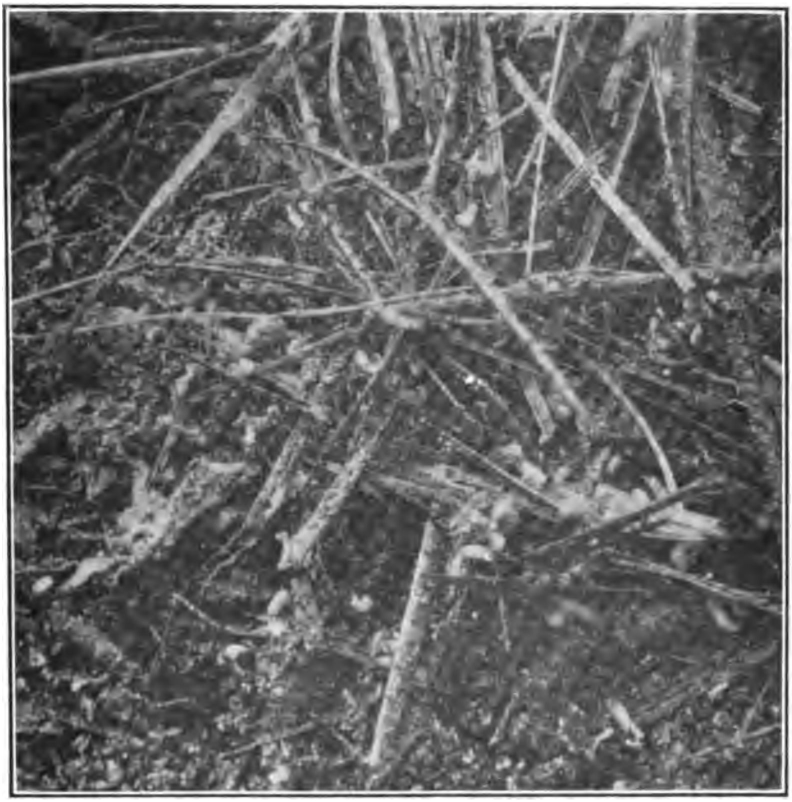


Fig. 8 A mass of horse manure showing larvæ (maggots) of the common house fly. Photograph by L. M. Peairs.

the development of twelve or thirteen generations in the climate of Washington every summer."

MEANS OF CONTROL

On account of their omnipresence the task of getting rid of house flies would seem too great. Fortunately the matter is much simpler than we might expect. It simply means a proper care in the disposal of their preferred larval food, horse manure, and the maintenance of proper sanitary conditions around the house and vicinity. In cities, and especially in towns and villages where sewerage systems are absent and where adequate means of sewerage disposal are rarely present, such conditions should be governed through an ordinance by the Boards of Health or other designated officials.

Little will be accomplished by a few persons in a town or community in preventing them gaining access to their breeding places, if some neglect this duty, for a single pile of horse manure allowed to stand in the open will serve to furnish flies for a whole neighborhood. The greatest good therefore will result from the combined efforts of all persons keeping stables in a community in either having the manure removed from the stables and vicinity twice a week or keeping the manure in a screened portion of the stable, treating it after each addition with air-slaked lime. Dr. Howard has shown how the presence of flies in a neighborhood of the city of Washington was materially reduced by such treatment of the manure from a horse stable nearby. The task of combating the pest in rural districts and around farm houses is largely an individual one and its presence in large numbers or to a limited extent will depend upon the sanitary conditions that are maintained around the house and barn. It is good farming practice to remove the fresh manure from the barns to the fields at least twice a week and if this is done and other sources of breeding material are protected the pest will be largely mitigated around the home.

As indicated heretofore the question of protection of privies or open deposits of human excrement from access of flies either for breeding or visitation is of the utmost importance, for, as stated, it is by this means that the fly assembles the germs of disease and distributes them to any exposed food. It cannot be too strongly urged that all such places be constructed as sanitary as possible and free use of earth or lime be made for covering all deposits. The dropping of human excrement in the open in our towns and villages or around our farm homes should never be tolerated. It is not to be presumed that even under the best regulated conditions it will be possible to entirely eradicate this most common pest on account of the ever abundant field for its development. It therefore behooves every housekeeper to keep at least all eatables protected from flies. Too often it will be seen that the parlor is kept dark or screened from flies while they may be present in great numbers in the kitchen or dining room crawling over all food being prepared for consumption.

Therefore screens should be freely used to prevent the flies gaining access to the home; also strict sanitary measures employed in disposing of waste material.

The use of sticky fly papers or other patented means of catching flies that have accidently entered the house is the easiest means of catching them. Fumigation with pyrethrum (Persian insect powder) is recommended when the flies are present in great numbers.

These measures should particularly be adopted by our merchants and those conducting eating houses, markets and dairies, etc., who serve the public with food that is likely to be contaminated by the dirty germ-laden house fly.

THE MOSQUITO PEST

To the great majority of our people, the mosquito like the house fly is looked upon as an unavoidable nuisance, over the presence of which we have no control. Seldom do we stop to think or investigate sources of this troublesome pest. We simply try to keep them out of the house by screens or other protection and if some do gain access an effort is made to kill them one by one whenever opportunity affords. When occurring in enormous numbers in country districts, especially serving as a continual irritant to man in his daily labors and as a source of constant annoyance to domestic animals they are simply tolerated, and the hope is expressed that the wind will change or that the insect will take a notion to lessen its attack. Moreover, if one of the family is attacked by chills and fever, even with a mild attack of malaria fever, it is the usual custom to attribute such sickness to unusual exposure to the night air or the contaminating influence of swampy areas during the spring and summer months. In addition to acting as an agent in the transmission of specific diseases any species of mosquito may disseminate blood and intestinal diseases by inflicting wounds with a proboscis contaminated with fecal bacteria.

While only a few particular species of mosquitoes exact a toll of human lives through transmission of disease and many species cause pecuniary loss by depreciation in real estate by virtue of their presence, it would perhaps be better if the mosquito should be an important factor in causing damage to some of our agricultural crops, for in such case active measures would be taken throughout the land to prevent their appearance and extermination of the pest would be vigorously prosecuted as is the practice with other insect pests. Unfortunately, this is not the case and such measures looking toward their control or extermination have only been undertaken where their presence has affected the financial interests of the communtiy or where the people as a whole have been educated to the point of appreciating the comparative ease with which freedom from the pest is obtainable.

It is hoped that in this age of progressiveness our people will appreciate the possibilities of protection of human life; the great increase in land valuation and the benefit to man and animals by conducting, in the near future a State-wide campaign looking towards the control and extermination of mosquitoes.

Malaria

Among the revelations of medical science of recent years no one was more astounding to the popular mind or broader in its effect upon mankind than the finding through scientific investigation that the malaria fever can only be contracted through the bites of species of mosquitos belonging to the genus Anopheles. Thus it will be seen that this, the most common and widespread of infectious diseases and one whose cause was attributed to innumerable sources, can be prevented by the extermination in inhabited districts of the species of mosquitos responsible for its development.

It would be difficult to estimate the economic loss to the State of Maryland from malaria. Simply enumerating the number of deaths from the disease would only partially state the case. As a matter of fact a comparatively small per cent die of malaria directly. But many ultimate deaths are brought on by complications which first originated in an attack of malaria. But the deaths resulting directly or indirectly from this disease comprise only a part of the economic loss which it represents. Dr. Howard in Bulletin 78 already referred to estimates that this productive capacity of individuals attacked by the disease is reduced at least one-quarter. He further states that "accepting this as a basis; and including the loss through death" which he approximates at three million in the United States annually, "the cost of medicines, the losses to enterprises in malarious regions through the difficulty of securing competent labor and other factors, it is safe to place the annual loss to the United States from malarial diseases under present conditions at not less than one hundred millions of dollars." Maryland undoubtedly gives her share of toll to malaria as from its climatic and topographical conditions, at least in the eastern, central and southern parts, the State offers many advantages for the development of malarial mosquitoes.

The preliminary investigations published in Bulletin 109 of this Station and observations since that date show that the districts in the State where the malarial mosquito breeds are extensive. Four species of the genus Anopheles have been found but the species Anopheles maculipennis is considered to be the most malignant in the transmission of malaria. Inasmuch as the mosquitoes of the genus Anopheles, while preferring grassy pools of clear, clean water, are found breeding everywhere in tin cans, troughs, etc., their numbers can be largely lessened by private or individual efforts at control.

Yellow Fever

It is only necessary to mention this dreaded disease in connection with this discussion on account of the possible importation of the yellow fever mosquito Stegomyia calopus into our domain through steamboats or other means of transportation. The findings of Dr. Finley supplemented by the investigation of the United States Commission and many other scientists show that yellow fever is carried by the above species of mosquito and that it constitutes the only known means by which the disease is spread. This species of mosquito is quite abundant in the Southern States and is likely to be imported at any time and if so, during summer months will reproduce very rapidly if favorable breeding places are available.

Maryland's Problem

Aside from the danger to health due to the presence of malarial mosquitoes the mosquito as a pest to man and beast is of such magnitude in many parts of this State as to be of sufficient moment to warrant immediate action on the part of the State government. The Maryland Weather Service reports that there are approximately 124,252 acres of fresh water swamps and 204,416 acres of salt water marshes out of a total area of 6,310,400 acres of land in the State. The proper drainage of this swamp land in itself offers an abundant field for development and the greatly increased assessed valuation would in a comparatively short period more than repay the necessary expense of the work, not to mention the lasting benefits which would accrue from the improvement of such lands and a corresponding growth of the community. This is doubly emphasized when it is realized that such work, together with individual effort, would largely mitigate the mosquito pest of a vicinity.

The foresight of such State policy has been conclusively demonstrated by our sister State New Jersey, where the State Entomologist is directing the expenditure of a $300,000 appropriation made by the State for mosquito control through drainage of her swamp lands. On a basis of cost in draining ordinary swamp lands which varies from $1.50 to $2.50 per acre in New Jersey, it would require about $500,000 to conduct the work in this State, but this sum while it seems large at first sight would soon be returned to the State by the improvement of such lands.

This department has been working on the problem to a limited extent with practically no available funds for the past four years. It is hoped that sooner or later the State government will be in a position to take up the problem and after a thorough investigation conduct drainage operations which will not only greatly improve the health and land valuation in such districts but will serve to remove this ever appearing mosquito pest.

As indicated in the introduction the real purpose of this discussion of the mosquito is to stimulate an interest in the individual as to the importance and ease with which the presence of this pest can be largely decreased around the home under normal conditions. It likewise applies to the city, town or village where the control of the pest is simply a local problem. The description and life history of the common house mosquito (Culex pipiens) taken from Bulletin 109 will serve to show the habits of those species that commonly breed in local communities.

THE HOUSE MOSQUITO

(*Culex piviens*)

"This species is probably the most abundant one in the State for it is found in cities, towns and country districts in large numbers and is annoying as a persistent biter. The adult is a mosquito of medium size, the head being brown, with a few yellow scales and a yellow border to the eyes. The beak is brown, darker towards the apex, and somewhat thicker and shorter in the male than in the female; the thorax is brown, with many golden scales scattered over the surface; the abdomen is blackish brown, with yellowish moderate or narrow bands at the base of the segments. The mosquitoes vary considerably in size and color, but are easily recognized by the fact that they have no strikingly characteristic marking. It is the common, everyday brown mosquito (see Fig. 9).

The adult is persistent in its attempts to gain entrance indoors. Just at twilight on summer evenings it can be seen hovering against the sides of buildings and may rise to the second or third story, seeking entrance through crevices in screens or doors. It hibernates in the adult stage in any sheltered place about human habitations. Cellars, attics, stables, outhouses or closets may furnish it winter quarters. Hibernation begins early in the autumn, before breeding ends. It is said by some that only the impregnated female hibernates, but I have seen great numbers of males of this species in the early spring, before any breeding had occurred, apparently recovering from their long winter sleep.

Culex pipiens is not a migratory form and flies no further than is necessary to secure food or to find a suitable place to oviposit. Dr. Smith says that blood is not necessary for this species for the development of the ovaries.

In the spring, when warm weather has come, the hibernating females awaken, seek food and deposit their eggs. The female oviposits in early morning or at night in any suitable body of water. The eggs of this species are laid in egg boats or rafts, as illustrated in Fig. 10, each containing 300 to 400 eggs. The length of the life cycle is from 10 to 16 days in summer months.

The number of broods of Culex pipiens during the summer is indefinite and depends upon the favorableness of conditions. During warm, rainy seasons, when plenty of puddles exist, it breeds rapidly. A single rain barrel, as shown in Fig. 11, may produce hundreds of thousands of this annoying pest in a comparatively short time.

The larva is very active. The breathing tube is of moderate length and the larva hangs head down and at an angle with the surface of the water when breathing. This position is characteristic of most of the species of Culex, the Anopheles differing from them in resting flat on the surface of the water.

The larvæ feed upon animal and vegetable matter in the water. In

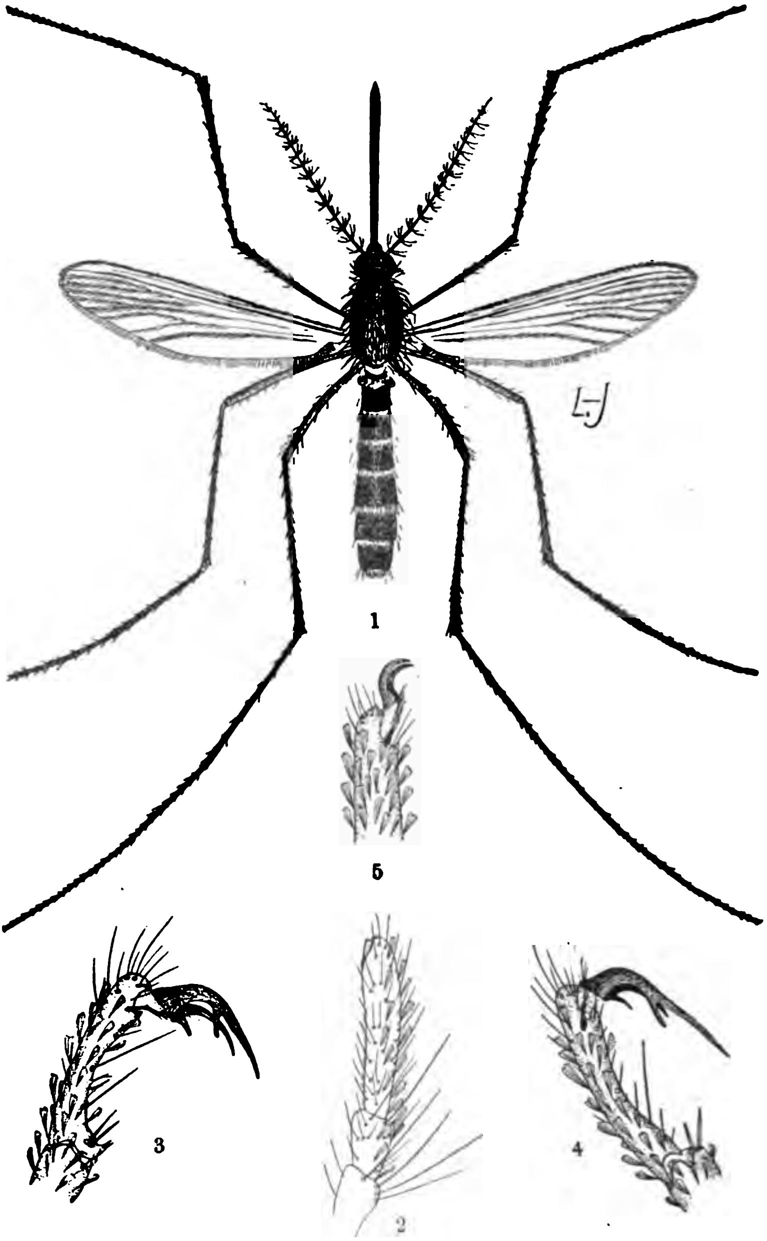


Fig. 9 Culex pipiens; 1, adult female; 2, palpus; 3, anterior; 4, middle; 5, posterior claws of male; all enlarged. (After Smith, Report of Mosquitoes of New Jersey.)

a glass jar one sees them feeding in the mud and debris at the bottom. They may feed on the cast larva skins, small leaves, etc. The larvæ can be found almost anywhere, but especially in stagnant water about human habitation. Excessive foulness of water does not deter their development. Culex pipiens begins to breed in the early spring and continues its activities up to the early fall in Maryland."

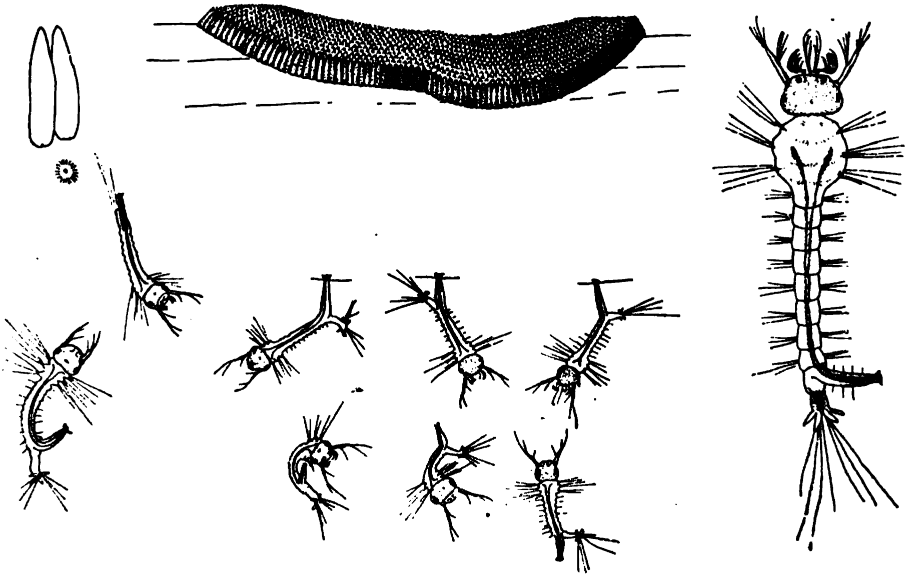


Fig. 10 Culex pipiens, egg mass, with enlarged eggs at left and young larvæ below, enlarged. After Howard, Bulletin 25, New Series, Bureau Entomology, United States Department Agriculture.

Means of Control

From the preceding discussion it is seen that the house mosquito can only breed where there is available water standing for a week or more. The water may be located in any conceivable place, in old tins, rain barrels, buckets, tubs, eave-troughs, cess pools, sewers, cisterns, or in fact anything within or without and around the home. As water is necessary to four stages of the insect's life the doing away with such stagnant water in vessels around the home is the most practical and, in fact, the only real means of preventing their breeding. The use of kerosene upon such bodies of water will serve as temporary relief by killing all larvæ or pupæ that are present when applied, but at the first rain the film of oil is likely to be washed away, and breeding may again be continued. In the case of cess pools, fire buckets or such receptacles that are not subject to influence of natural conditions the use of kerosene can be employed without much trouble provided such treatment is repeated from time to time. However, such places should be made inaccessible to mosquitoes. Briefly, the solution of the mosquito prob-

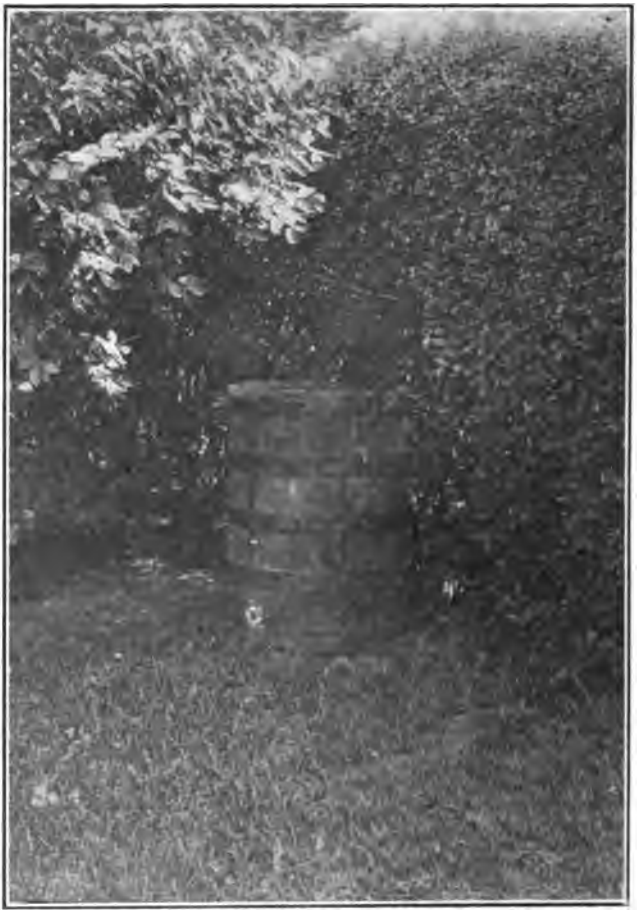


Fig. 11 Neglected barrel beneath hedge furnishing breeding place for thousands of mosquitoes. Photograph by A. B. Gahan.

lem lies in simply doing away with their breeding places by drainage or otherwise, and killing by fumigation or other means all overwintering adults that may be seen in cellars, attics or other places. In city, town or village it is incumbent upon the members of the Board of Health to see that no breeding places of the pest exist in the community. In fact, where feasible, regulations should be made designating such places as nuisances to be abated as such.

In conclusion let one and all strive to keep his or her own place free from such harbors or breeding places of this most common pest and it will be seen that such coöperative effort will mean much in the diminution of the presence of the insect.

THE MARYLAND
Agricultural Experiment Station

BULLETIN No. 135 MAY, 1909

BUTTER MAKING IN MARYLAND

BY C. W. MELICK

INTRODUCTION

There are 46,000 farms in Maryland and over three-fourths of them keep cows. These farms are stocked with nearly 150,000 cows, or an average of nearly four cows per farm. There are over 3000 farms which are classified as dairy farms or farms on which dairying is made a specialty. On these farms there is an average of about nine cows per farm.

The statistics as to the various products of the cows and their distribution are given in the table on the next page.

From these figures we see that the value of the dairy products of this State is over five and one-quarter millions of dollars annually and, large as this sum may seem, a little calculation will show that the average income is less than $40 per cow or, in reality, less than sufficient to feed a cow if the feed was charged at market prices.

These figures indicate that the average yield of milk is about 430 gallons or 3600 pounds of milk per cow per year. If this milk would test 4 per cent butter fat it would make the yield per cow equivalent to only about 170 pounds of butter per year. It is generally estimated that a profitable cow should yield at least 300 pounds of butter per year.

MARYLAND CREAMERIES

There are nearly 80 creameries or butter factories in Maryland. Some of these dispose of all their product as butter while others dispose of a portion of it at some seasons as cream or ice-cream.

Dairy Products of Farms in Maryland

COUNTIES	NUMBER OF FARMS REPORTING DAIRY PRODUCTS	VALUE OF ALL DAIRY PRODUCTS	VALUE OF DAIRY PRODUCTS CONSUMED ON FARMS	MILK		CREAM	BUTTER		COTTAGE CHEESE	
				Gallons produced	Gallons sold	Gallons sold	Pounds made	Pounds sold	Pounds made	Pounds sold
The State......	36,009	$5,228,698	$1,709,854	64,040,517	20,654,446	135,169	9,096,662	5,828,684	338,453	328,577
Allegany......	806	113,577	50,902	1,013,108	200,219	2,060	183,300	104,856	1,352	1,275
Anne Arundel.	1,161	118,781	74,798	973,188	170,924	707	152,593	45,729	2,192	2,028
Baltimore.....	3,641	1,103,039	187,615	10,370,504	5,295,885	20,543	1,075,274	731,099	318,454	314,766
Baltimore City.	86	108,092	5,901	605,770	515,412	2,390	12,190	4,584	....	....
Calvert.........	900	50,042	45,663	480,375	11,850	68	35,775	10,631	212	135
Caroline.......	1,331	88,883	53,178	1,351,051	135,502	122	260,683	124,074	21	....
Carroll.........	3,007	527,957	99,800	7,690,576	2,561,193	5,464	1,258,700	1,047,330	20	....
Cecil...........	1,477	241,230	64,737	3,641,622	1,451,044	487	484,790	339,203	....	....
Charles.........	1,474	70,487	62,584	812,086	21,247	....	133,555	25,510	....	....
Dorchester....	1,391	79,744	48,777	1,159,085	223,552	41	158,372	66,810	....	....
Frederick......	3,330	525,672	120,887	8,745,300	2,268,780	51,610	1,493,740	1,146,740	3,050	2,400
Garrett.........	1,637	172,702	95,640	2,176,704	197,152	1,091	420,883	256,237	102	101
Harford.......	1,622	426,960	91,524	5,268,218	2,681,651	576	566,243	338,471	....	....
Howard.......	1,071	171,077	54,988	2,276,540	361,298	9,598	459,873	336,786	....	....
Kent..........	797	105,019	31,665	1,800,378	884,450	505	136,027	82,466	....	....
Montgomery...	1,768	450,230	102,101	4,214,832	2,085,241	21,010	320,835	247,944	1,607	1,583
Prince George.	1,532	188,488	98,030	1,674,568	415,749	707	215,393	74,922	51	....
Queen Anne....	1,202	89,568	50,169	1,549,988	369,736	645	173,545	75,265	....	....
St. Mary.......	1,070	54,503	49,934	622 063	4,042	12	107,538	19,208	105	....
Somerset.......	856	51,051	36,422	580,653	43,472	10	111,714	39,093	185	....
Talbot.........	985	86,346	47,416	1,333,438	312,595	....	172,370	71,973	561	505
Washington....	2,073	231,131	97,581	3,733,544	394,499	17,440	793,073	508,775	9,844	5,289
Wicomico.....	1,389	79,273	60,117	963,856	27,945	83	187,881	73,640	54	....
Worcester.....	1,403	94,846	79,425	1,003,070	21,008	....	182,315	57,338	643	495

The creamery industry of this State is probably not as large as it was ten years ago and it has not been as successful as it should have been, consequently it has not made the growth which circumstances would seem to have warranted.

Some creameries have been discontinued because of the extension of the area for the shipment of milk and cream which has proved more profitable than butter, but there still remains many sections of the State which seem to offer an opportunity for the creamery industry and which no doubt would have been developed had more encouragement been received from the reports of those sections where creameries were operating.

There are a few sections where creameries have been abandoned because of insufficient support but in most cases the support would have been forthcoming had they proved of greater financial benefit to their patrons.

Many of the creameries were not properly planned and equipped and many paid too much for the equipment they had. Most of the creameries in this State have failed to recognize that the operator or buttermaker should be a person skilled and trained in the work. The attempt to use untrained buttermakers has resulted in the turning out of a product deficient in quality and uniformity and consequently has not brought the creamery or its patrons the profits which they should have had or which were expected.

Many creameries produce at times as good butter as any market demands and some creameries always produce a good quality of butter, but in both cases they fail to turn out a uniform product. In order to establish a reputation and a good market for its products a creamery cannot be too particular or lay too much stress on having its butter uniform. A uniform product should look, smell and taste the same every week in the year. With a good and uniform product a good market can be established. A trade cannot be held with a product lacking uniformity, even though the individual shipments or week's output is of good quality.

The prevailing fault of Maryland creameries is a lack of uniformity. Many of them produce a high quality of butter, but it is too variable to establish a brand and hold a definite trade.

INVESTIGATIONS CONDUCTED

In order to determine some of the causes for lack of uniformity of butter made at Maryland creameries, this Station conducted some investigations at a few representative creameries in five different counties of the State. The investigations may be classified as follows:

1. An inspection and score of the patrons' herd, facilities and premises.
2. Grading the milk according to score and churning each grade of cream separately.
3. Determining the bacteria content, the acidity, and making a curd test of each patron's milk.
4. Noting the methods employed by the creameries.
5. Determining the commercial grade and value of butter derived from different qualities of milk.

CREAMERIES INVESTIGATED

The investigations were conducted at the following points:

1. "White House" Creamery located in Baltimore County 5 miles east of Hampstead.
2. Harford Creamery located in Harford County 8 miles east of White Hall.
3. Cold Spring Creamery located in Carroll County at New Windsor.
4. Sparrows Point Store Co.'s Creamery, located in Frederick County at Mt. Pleasant.
5. Easton Creamery located in Talbot County at Easton.

METHODS FOLLOWED

The plan followed was to procure a list of the patrons of each creamery and then proceed to visit each one and make an inspection of their premises, herds, and methods employed, and score the same according to the score card adopted by the Dairy Division of the U. S. Department of Agriculture.

After this data was obtained the inspector returned to the creamery to make a churning test, and to determine the bacteria content of the milk of the different patrons. The milk that received a score of 80 or above was placed in group or grade No. 1, and that under 80 in group or grade No. 2. The milk from the patrons in different groups or grades was placed in different vats. Each grade was separately churned and treated the same at each creamery, and butter from each lot submitted to several experts for judging as to its quality.

The butter was scored according to official points which for perfect butter is as follows:

Flavor	45
Texture	25
Color	15
Salt	10
Package	05
Total	100

INVESTIGATIONS AT "WHITE HOUSE" CREAMERY

The investigations were begun on February 6, 1908, at the "White House" Creamery, located five miles east of Hampstead in Baltimore County.

A list of the patrons, twenty-nine in number, was secured and the premises of each visited and scored.

After scoring the patrons' dairies their milk was graded as it was delivered at the creamery, and placed in different vats according to grade. The following represents the score of their dairies and milk, and the quantitative analysis of the bacteria present in the milk at the time of delivery. Group No. 1 represents the patrons whose milk scored 80 or above and was placed in the first grade lot. Group No. 2 represents the patrons whose milk scored below 80 and was placed in the second grade lot.

Average Detailed Score of Patrons in Groups I and II of White House Creamery

EQUIPMENT.	SCORE. Perfect.	SCORE. Allowed.	SCORE. Allowed.
		Group I.	*Group II.*
Cows			
Health	6	2	2
Apparently in good health 1			
If tested with tuberculin once a year and no tuberculosis is found, or if tested once in six months and all reacting animals removed 5			
(If tested only once a year and reacting animals found and removed, 2.)			
Comfort	2	2	2
Bedding 1			
Temperature of stable 1			
Food (clean and wholesome)	2	1.5	1
Water	2	2	2
Clean and fresh 1			
Convenient and abundant 1			
Stables.			
Location of stable	2	1	1
Well drained 1			
Free from contaminating surroundings 1			
Construction of stable	4	1	0
Tight, sound floor and proper gutter 2			
Smooth, tight walls and ceiling .1			
Proper stall, tie, and manger ..1			
Light: Four sq. ft. of glass per cow	4	0	0
(Three sq. ft., 3; 2 sq. ft., 2; 1 sq. ft., 1. Deduct for uneven distribution.)			

METHODS.	SCORE. Perfect.	SCORE. Allowed.	SCORE. Allowed.
Cows.		*Group I.*	*Group II.*
Cleanliness of cows	8	5	3
Stables.			
Cleanliness of stables	6	2	1.5
Floor 2		1	.5
Walls 1		.5	.5
Ceiling and ledges 1		0	0
Mangers and partitions 1		.5	.5
Windows 1		0	0
Stable air at milking time	6	3	2
Barnyard clean and well drained	2	1	1
Removal of manure daily to field or proper pit	2	1	.5
(To 50 feet from stable, 1.)			
Milk Room.			
Cleanliness of milk soom	3	1.5	1
Utensils and Milking.			
Care and cleanliness of utensils	8	4	3
Thoroughly washed and sterilized in live steam for 30 minutes 5			
(Thoroughly washed and placed over steam jet, 4; thoroughly washed and scalded with boiling water, 3; thoroughly washed, not scalded, 2.)			
Inverted in pure air 3			
Cleanliness of milking	9	3	2
Clean, dry hands 3			
Udders washed and dried 6			
(Udders cleaned with moist cloth, 4; cleaned with dry cloth at least 15 minutes before milking, 1.)			

Ventilation: Automatic system (Adjustable windows, 1.)	3	0	0
Cubic feet of space for cow: 500 to 1000 feet (Less than 500 feet, 2; less than 400 feet, 1; less than 300 feet, 0; over 1,000 feet, 0.)	3	0	0
Utensils.			
Construction and condition of utensils	1	.5	.5
Water for cleaning (Clean, convenient, and abundant.)	1	1	1
Small-top milking pail	3	0	0
Facilities for hot water or steam (Should be in milk house, not in kitchen.)	1	.5	0
Milk cooler	1	0	0
Clean milking suits	1	0	0
Milk Room.			
Location of milk room	2	1	.5
Free from contaminating surroundings 1			
Convenient 1			
Construction of milk room	2	1	.5
Floor, walls, and ceiling 1			
Light, ventilation, screens 1			
Total	40	13.5	10.5

Handling the Milk.			
Cleanliness of attendants	1	.5	.5
Milk removed immediately from stable	2	1	1
Prompt cooling. (Cooled immediately after milking each cow))	2	0	0
Efficient cooling; below 50° F (51° to 55°, 4; 56° to 60°, 2.).	5	2	2
Storage; below 50° F (51° to 55°, 2; 56° to 60°, 1.)	3	1	1
Transportation; iced in summer (For jacket or wet blanket allow 2; dry blanket or covered wagon, 1.)	3	1	1
Total	60	26	19.5

Group I. Score for equipment 13.5 + Score for methods 26 = 39.5 Final Score.
Group II. Score for equipment 10.5 + Score for methods 19.5 = 30 Final Score.

NOTE 1.—If any filthy condition is found, particularly dirty utensils, the total score shall be limited to 49.

NOTE 2.—If the water is exposed to dangerous contamination or there is evidence of the presence of a dangerous disease in animals or attendants, the score shall be 0.

GROUP 1

Patrons No.	SCORE		
	Premises	*Milk*	*Bacteria per cc.*
1	35.5	89	600,000
2	38.0	86	1,000,000
3	38.5	85	500,000
4	40.0	84	700,000
5	41.5	86	500,000
6	38.5	91	500,000
7	41.0	81	700,000
8	38.5	91	800,000
9	41.5	85	100,000
10	40.5	93	1,000,000
11	39.0	83	800,000
12	35.5	83	400,000
13	40.5	95	620,000
14	40.5	82	1,200,000
15	44.0	95	800,000
Average	39.5	87.3	681,333

GROUP 2

Patron No.			
16	27.5	48	2,000,000
17	28.0	49	1,440,000
18	32	81	1,000,000
19	32	48	1,440,000
20	32.5	56	1,200,000
21	32	72	1,200,000
22	32	72	
23	31	61	1,000,000
24	28.5	79	1,500,000
25	28.5	74	1,800,000
26	30	76	1,200,000
27	30	67	1,100,000
28	29	59	200,000
29	27	68	600,000
Average	30	65	1,206,154

AVERAGE SCORE OF MILK

		Standard Score	*Group 1*	*Group 2*
Condition	Cleanliness	15	12.3	10
	Bacteria per cc.		681,333	1,206,154
	Acidity	10	9	5
Flavor	Taste	25	22	15
	Smell	25	23	18
	Curd test	25	21	13
		100	87.3	61

On February 21 the milk from both groups was again scored as it arrived at the creamery, and after separating, the cream from each was ripened at 70° F., until 6 o'clock in the evening. It was then allowed to cool down to 60° F., and by the following morning had reached a temperature of 48°F.

Each churning was made under identical conditions as follows:

There was no pasteurizer at this creamery and no starter was used in ripening the cream.

The acidity of the cream when churned was 6 per cent, the temperature was 56° F., the churn was about one-third full each time, the butter granules were about the size of wheat grains, and the butter was washed twice with water at 50° F.

	1st Grade Cream	*2d Grade Cream*
Pounds of cream	300	250.
Per cent fat in cream	21	18
Pounds of butter fat	63	45
Grade of cream	94	75
Temperature of creamery	44°F.	42°F.
Amount of vegetable color used	35cc.	27 cc.
Time required to churn	18 min.	40 min.
Temperature of butter	50°F.	48° F.
Temperature of buttermilk	48°F.	47°F.
Acidity of buttermilk	.82	.83
Amount of salt used	6 lb.	4 lb.
Amount of salt used per lb. butter	1.28 oz.	1.29 oz.
Per cent of fat in buttermilk	.2	.25
Pounds of fat lost in manufacture	.469	.45
Per cent of fat lost in manufacture	.74	1.01
Pounds of butter made	75.5	50
Per cent overrun	19.8	11.1
Per cent moisture	16	15

SCORE OF BUTTER WHEN MADE

	Perfect Score	*Group 1 Cream*	*Group 2 Cream*	*Mixed Cream*
Flavor	45	37	34	34.5
Texture	25	24	24	23.5
Color	15	15	15	15
Salt	10	10	10	10
Package	5	5	5	5
	100	91	88	88

Samples of butter (from the first and second grade cream) together with samples of butter from the mixed cream of the creameries' average make, were numbered and sent to the following places for scoring: The Dairy Division of the U. S. Department of Agriculture; M. M. Rouzer, Butter Expert of the Central Market, and Geo. F. Oyster, butter and egg commissioner of Washington, D. C., and S. S. Edel's Sons, and Robins & Co., butter commissioners of Baltimore.

	No. 1	*No. 2*	*No. 3*
Experiment Station Official	91	88	88
Government Expert	92	89	89
Central Market, Washington	89	85	86
Butter Commissioner, Washington	93	86	87
Butter Commissioners, Baltimore	91	84	84
Butter Commissioners Baltimore	94	90	87
	91.6	87	86.8

REMARKS

Government Expert, B. D. White: "Good butter for this time of the year. Wintry, cowstable flavor."

Central Market, M. M. Rouzer: "There is from three to five cents difference in that butter on this market."

S. S. Edel's Sons: "We find these samples good winter butter. No. 2 is sour and on the turn to rancid. In regard to difference in present prices on the market we assume that sample No. 1 would pass as extra, bringing top price. Samples 2 and 3 as firsts about three cents less.

The Baltimore and Washington Markets on the days in which the scoring was done, February 24 and 25, quoted butter as follows:

	Washington	*Baltimore*
Extras	33½ to 34½	33 to 34
Firsts	31 to 33	29 to 32
Seconds	26 to 27	26 to 27

Butter scoring above 90 per cent is classed as extras, from 80 to 90 as firsts and below 80 as seconds.

According to the score of B. D. White (the government expert who is considered one of the best butter judges in America) and G. F. Oyster, the butter made from the cream from group 1 would be classed as extras, and that from group 2 as firsts, making a difference of from 4½ to 7½ cents a pound in the Washington market and from 1 to 5 cents a pound in the Baltimore market. According to Mr. Rouzer they would be classed as firsts and seconds, making a difference of from 4 to 7 cents a pound on the Washington market in which he works.

INVESTIGATIONS AT THE HARFORD CREAMERY

On March 12 the work was taken up at the Harford Creamery, located in Harford County, eight miles east of White Hall, Md.

The premises of the patrons were scored, the milk graded at the creamery, and butter made from the two grades of cream as in the previous experiment.

At this creamery the milk was pasteurized and the cream ripened with starter made from commercial culture. This must be borne in mind in comparing the reports of the judges with those of previous experiments, for it is generally conceded that such treatment of the cream materially lessens the difference which would ordinarily occur between the number one and two grades.

The score of the patrons premises and grade of the milk were as follows:

GROUP 1.

Patron's No.	*Average Premises*	*Score of Milk*	*No. Bacteria per cc.*
1	34	74.2	325,000
2	41	87	300,000
5	40	85	290,000
6	40.5	87.7	600,000
9	42	82	160,000
15	31.5	82.5	270,000
16	43	89	700,000
32	34.5	78	1,900,000
34	32	88	1,000,000
35	31.5	81	900,000
36	44	87	250,000
42	40	86	420,000
Average	37.83	83.95	592,916

GROUP 2

3	33.5	84	400,000
7	37	65	1,050,000
8	28.5	62	1,500,000
10	32.5	80	700,000
11	34	71.5	190,000
12	30.5	65	950,000
13	40	65	410,000
14	41	74	190,000
17	36	70	310,000
18	23	73	620,000
19	32	65	160,000
20	32	72	400,000

GROUP 2—Continued

Patron's No.	*Average Premises*	*Score of Milk*	*No. Bacteria per cc.*
21	44	63	520,000
24	31	69	480,000
25	35	70	530,000
26	32	85	480,000
27	27	70	800,000
28	34	70	680,000
29	37	70	750,000
31	28	68	910,000
33	33	77	740,000
37	30.5	71	970,000
38	31	74	1,100,000
39	32.5	78	1,000,000
40	34	70	600,000
41	27	76	620,000
Average	32.88	72.13	656,154

Average score of milk and dairies.

GROUP 1 *Milk*		*Dairy*	GROUP 2 *Milk*		*Dairy*
Condition:			*Condition:*		
Cleanliness 13.			Cleanliness 11.		
Bacteria per cc. 592,916			Bacteria per cc. 656,157		
Acid .29	8		Acid .38	6	
Flavor			*Flavor*		
Taste	21.4		Taste	18	
Smell	22.4		Smell	20	
Curd test	20		Curd test	17.5	
	84.8	72		72.5	70

In grading the milk on March 22 the samples of patron 19 tasted watery. An analysis was therefore made on March 24 and 26 which showed 30.12 per cent and 35.53 per cent of water adulterations respectively.

When the milk from any patron scored below 80 it was placed in number two vat regardless of home conditions. It was evident from this scoring that some of the patrons, although having inferior equipment, were careful and comparatively clean in their methods of handling the milk.

The cream was all pasteurized and ripened with and without starter for comparison.

Every batch of cream was ripened at 70° F., and churned at 55° F. The butter was washed once with one-fourth of churn full of water at 50° F. A hand churn was used for churning number 3 on March 26.

The report of the churnings is given in the following table:

	MARCH 22	MARCH 24		MARCH 26		
	Mixed Cream	1st Grade	2nd Grade	1st Grade	2nd Grade	3rd Grade
Pounds of cream	850	680	319.2	123	700	25
Per cent fat in cream	30	20	23	31	18	18
Pounds of butter fat	255	136	73.41	38.13	126	4.5
Per cent acid in cream	.6	.54	.59	.41	.71	.69
Per cent starter added	5	5	5	10	20	73
Grade of cream before adding starter	87	98	78	98	73	73
Grade of cream after ripening	91	98	90	98	88	80
Temperature of creamery	48	50	54	42	42	42
Amount vegetable color used	5.5 oz.	4 oz.	1.5	1.25	33.25	.25
Churn how full	3/5	1/3	1/6	1/3	1/3	1/3
Time required to churn, min.	30	10	12	25	20	20
Temperature of butter	55	55	56	55	55	55
Temperature of buttermilk	54	55	56	54	54	54
Acidity of buttermilk	.7	.68	.74	.61	.77	.7
Amount of salt used	17 lb.	15 lb.	5 lb.	4 lb.	12 lb.	½ lb.
Amount of salt used per pound butter	.97 oz.	1.6 oz	1.1	1.5 oz.	1.45 oz.	1.8 oz.
Per cent fat in buttermilk	.3	.25	.3	.2	.28	.25
Pounds fat lost in manufacture	1.7	1.31	1.72	.15	1.58	.05
Per cent fat lost in manufacture	.66	.96	2.34	.52	.22	1.10
Pounds butter made	281	152.5	77	45	135.5	4.5
Per cent overrun	10.19	12.28	4.86	18.01	7.54	0
Per cent moisture in butter (per cent)	14.28	16.66	14.0	15	14	16

Samples of the butter from these churnings were numbered as follows and sent to various judges.

The churning of March 22, numbers 5 and 55 contained the entire batch of mixed cream from all patrons, and 5 per cent of starter was added. Numbers 1 and 11 were samples from No. 1 cream on March 24, to which 5 per cent of starter was added. Numbers 2 and 12 were from No 2 cream of the same date which also contained 5 per cent of starter. Numbers 13 and 15 were from No. 1 cream, March 26, containing 10 per cent of starter, and numbers 22 and 24 were from No. 2 cream on that date and containing 20 per cent of starter. Numbers 3 and 33 were samples from the same cream as those of 22 and 24, No. 2 cream, but to which no starter was added.

Results of Scoring.

Number	5	55	1	11	2	12	13	15	22	24	3	33
Experiment Station Official	92		94		90		94		91		86	
Gov't Expt., B. D. White	92	91.5	93.5	93	91	91.5	93	93	92.5	92	86	86
S. K. Keller, K St., Market, Washington, D. C	90	90	91	92	91	90	93	94	92	92	85	85
Rudurd & Co., Central Market, Washington, D. C.	91	92	92	92	90	90.5	94	93	92	93	80	80
Edel's Sons, Baltimore	83	85	88	88	75	80	95	94	85	90	71	73
Robins & Co., Baltimore	85	91	88	88	86	88	90	91.5	92.5	93	83	85
Average	88.8	90.3	91.1	91.1	87.1	88.3	93.3	93.3	90.8	91.8	81.8	82.5

REMARKS

Experiment Station Official: "Numbers 13 and 15 had a clean, nutty flavor, numbers 1 and 11 had a mild flavor. All others had an unclean flavor which was more pronounced in numbers 3 and 33."

Government Expert: "It is all fair butter except 3 and 33 which has a musty, unclean flavor."

K Street Market, Washington: "It would all pass as firsts on this market except numbers 3 and 33. They would be classed as seconds."

Central Market, Washington: "All firsts except 3 and 33. They are thirds."

Edel's Sons, Baltimore: "Numbers 2, 12, 3, 33, 5, and 55 are rancid."

Robins & Co., Baltimore: "The majority of the samples were a little light in color and salt for this market."

INVESTIGATIONS AT COLD SPRING CREAMERY

The investigations were resumed on April 13 at the Cold Spring creamery, of New Windsor, Md. The experiments of the two previous creameries were repeated. Among the forty-two patrons of the New

Windsor creamery there were only eight who delivered milk. The remaining thirty-four used hand separators and delivered cream.

No pasteurizer or starter was used at this creamery but the cream and milk was graded regularly and the butter made from each was sold for different prices according to quality.

The score of the dairies, and milk and cream of the patrons is given in the following table:

Patron No.	AVERAGE SCORE OF GROUP 1 *Premises*	 *Milk*	*No. Bacteria per cc.*
1	34.5	85	250,000
4	39	93	160,000
22	43.5	93.8	50,000
19	37.5	93	50,000
7	36.5	88.6	200,000
12	38.5	91	120,000
14	38.5	91	50,000
5	38.5	90	30,000
10	37	84	100,000
12	39.5	81	350,000
35	37	72.5	200,000
33	38.5	92	190,000
24	33.5	93.5	250,000
2	38.5	92.9	300,000
Average	37.9	88.6	164,286

Patrons having part of cream in Group 1 and part in Group 2.

No.	*Premises*	*Milk*	*Bacteria per cc.*
8	41	87	200,000
81	35.5	78	100,000
6	35	71	120,000
11	36.5	80	100 000
29	41.5	85	500,000
32	32.5	77	100,000
20	32	81	400,000
21	34	79	250,000
34	34.5	83	250,000
60	33	79	500,000
9	35	73	450,000
62	32	75.5	300,000
18	35	79	950,000
17	33	77.5	200,000
23	35	80	600,000
13	36	82.5	500,000
Average	35	79.2	345,000

SCORE OF GROUP 2

	Premises	*Milk*	*No. Bacteria per cc.*
3	30	72	600,000
36	37	75.5	130,000
27	25.5	77	200,000
16	30.5	67	950,000
60	32.5	68	600,000
34	38	78.4	550,000
64	33	75	450,000
Average	32.2	73.2	497,143

SCORE OF GROUP 3—GARLIC FLAVOR

Patron No.	*Premises*	*Milk*	*No. Bacteria*
61	27.5	70.3	300,000
63	32.0	81.4	150,000
26	31.0	73.8	300,000

AVERAGE SCORE OF MILK AND DAIRIES

Conditions:	*Group 1*	*Group 1 and 2*	*Group 2*
Cleanliness	13.5	12.5	11.7
Bacteria per cc	164,286	345,000	497.143
Acidity	8.1	6	6
Flavor:			
Taste	22	19.5	18
Smell	23	23.2	19.5
Curd test	22	18.0	18
Milk, total	88.6	79.2	73.2
Dairy	37.9	35.0	31.7

The cream was ripened after the usual methods employed at this creamery without the use of pasteurizer or starter. A temperature of 70° F., however, was maintained in ripening each batch. Garlic tainted cream was placed in a separate vat as third grade. The butter made at this creamery was all washed once, according to the existing custom, and with water at 55° F. The report of the churnings thus made is as follows:

	APRIL 18		APRIL 25		
	1st Grade	*2nd Grade*	*1st Grade*	*2nd Grade*	*3rd Grade*
Pounds of cream	814	1200	1200	825	560
Per cent of fat in cream	29	25	26.5	25	25
Per cent acid in cream	.5	.55	.5	.6	.6
Pounds of butter fat	236	300	318	206	140
Grade of cream before ripening	97	75	98	70	50
Grade of cream after ripening	96.5	76	98	70	50
Temperature when churned	55	56	54	53	54
Temperature of creamery	52	48	60	65	60
Amount Vegetable color used	2 oz.	3.5 oz.	3.5 oz.	2 oz.	1¼ oz.
Churn, how full	½	¾	¾	½	⅓
Time required to churn	20	30	30	20	19
Temperature of butter	54	55	60	61	60
Temperature of buttermilk	58	57	62	64	62
Acidity of buttermilk	.8	.9	.85	.9	.83
Amount of salt used	15 lb.	18 lb.	19.5	12 lb.	8 lb.
Per cent of fat in buttermilk	.3	.7	.2	.8	.6
Lbs. fat lost in manufacture	1.6	5.24	1.64	4.84	.66
Per cent fat lost in manufacture	.07	1.74	.51	2.35	.47
Pounds butter made	280.5	336.5	380	220	450
Per cent over run	19	12.1	19.5	6.8	7.14
Per cent of moisture	13	12	14	14.9	20
Score of butter when made: Scored by Experimental Station official	92	90	92	88	

The butter made on April 18 was numbered 1, 11, 2, 12; numbers 1 and 11 being churned from 1st grade cream, and 2 and 12 from 2nd grade cream. The butter made on April 25 was numbered as follows: From 1st grade cream 3 and 13, from 2nd grade cream 4 and 14, and from 3rd grade cream, 33 and 35. Samples of each were sent to various commission merchants in Washington and Baltimore and the Dairy Division of the United States Department of Agriculture, and the following reports thus secured. Samples were sent to two firms in Baltimore but in one instance the samples were mislaid and the report from that firm could not be included.

	1	11	2	12	3	13	4	14	33	35
Government Expert, B. B. White, Washington, D. C.: "With the exception of Nos. 33 and 35 it is all very good for this time of the year. Those samples I reject on account of garlic flavors"	90	91	90	90	91	91	88	87	0	0
H. C. Coburn, Central Market, Washington, D. C.	92	93	89	91	94	92	89	87	0	0
M. M. Rouzer, Central Market, Washington, D. C.: "Nos 1, 11, 3 and 13 are firsts. 2, 12, 4 and 14 are seconds and 33 and 35 are a low grade. I could not use them in this market"	89	90	85	86	90	91	87	85	0	0
Robins & Co., Baltimore, Md.: "Nos. 33 and 35 are so badly tainted with garlic that it has no grading on this market. Buyers are scarce and hard to find for such goods"	92	93	92	93	96	96	90	91	0	0
Average	90.7	91.7	91	90	92.7	92.6	88.5	87.5		

As will be seen from this table there was only a slight difference in the butter made from first and second grade cream. This was due to the fact that the cows of these patrons were milked for the most part in open yards and there was an absence of stable flavors in their milk. The defects of the second grade cream consisted of unclean and grass flavors. These were not as detrimental as the stable manure flavor found in the previous investigations during the months when cows were kept in the stables the greater part of the time.

According to Mr. Robins of Baltimore the butter made from first and second grade cream would all be classed as extras. According to Washington judges the butter from 2nd grade cream made on April 25 would be classed as firsts, worth from one to two cents less per pound than that of 1st grade of the same date and 1st and 2nd grade of April 18.

The price of butter on the two markets in question on April 30 when the scoring was done was as follows:

	Extras	*Firsts*	*Seconds*	*Thirds*
Baltimore	30 to 31	29 to 30	27½ to 28	19 to 20
Washington	30½ to 31½	29½ to 30½	28 to 29	21 to 22

Nos. 33 and 35, the butter from garlic tainted cream, was rejected in every instance, the garlic taint appearing even stronger in the butter than it was in the cream.

In this as in previous investigations the per cent of overrun was much larger in the churnings made from first than from second grade cream regardless of the fact that small churnings generally yield a higher per cent of overrun than large churnings.

The difference in value of the overrun is discussed later in this bulletin, pages 249 and 266.

INVESTIGATIONS AT THE SPARROWS POINT STORE COMPANY'S CREAMERY

The work was discontinued April 30 for the remainder of the season when the cows were kept on pasture and in open fields. Under such circumstances a more uniform condition naturally exists.

Investigations were resumed January 6, 1909, at the Sparrows Point Store Company's creamery at Mt. Pleasant, Frederick County, Md. A pasteurizer but no starter was used in this creamery. The butter was all being sold at the Company's store at Sparrows Point, Md. The patrons' barns all lacked light and ventilation, and were very similar to those of Carroll, Baltimore and Harford Counties, where the work was previously carried on. The barns usually served as combined horse and cow barns, and frequently possessed a loose ceiling or haymow floor where chaff sifted through. The manure piles were invariably too near the barn door, and some of the patrons milked with wet hands.

Very little first grade milk being produced at this creamery, only second and third grade churnings were made, and the patrons were accordingly divided into groups 2 and 3.

The score of the patrons' dairies and their milk was as follows:

GROUP NO. 2

Patron's No.	SCORE *Premises*	 *Milk*	*No. Bacteria per cc.*
2	37	70	200,000
3	37	85	100,000
4	46.5	72.4	250,000
11	37.5	71.4	250,000
13	37	74.8	290,000
14	45.5	74.4	300,000
15	37.5	71.4	310,000
17	46.5	70.8	180,000
18	39.0	80	300,000
19	42	77	500,000
20	37	71	225,000
25	37	70.2	400,000
30	44	75.2	400,000
31	43	73	300,000
Average	40.46	74.04	283,214

GROUP NO. 3

Patron's No.	SCORE *Premises*	 *Milk*	*Bacteria per cc.*
5	33	65	400,000
6	41	66.4	400,000
7	37	63.8	410,000
8	37	67.6	300,000
9	37.5	52	600,000
10	35	69.2	1,200,000
12	41	65.2	1,250,000
16	41	69.4	380,000
22	35	50.6	1,150,000
23	38	68.4	600,000
24	35.5	58	800,000
26	41.5	43.6	460,000
27	37	60	1,000,000
29	37.5	54.8	520,000
Average	37.64	61	676,427

The factory churn being too large to churn less than the entire amount of cream from the milk received at this season of the year, a hand churn was used in these investigations. The results compared favorably with those obtained by use of the factory churn when the entire amount of mixed cream was churned, and the latter are therefore used in the following table.

The cream was all ripened at 65° F. at this creamery, churned at .6% acidity, the churn was about one-third full each time, the butter was washed twice with water at 55° F., and one ounce of salt was added per pound of butter.

The following churning reports illustrate the differences in the butter made from the different grades of cream.

	JANUARY 14, 1909		JANUARY 15
	2d Grade Cream	*3d Grade Cream*	*Mixed 2d and 3d Grade*
Pounds cream	24	24	256
Per cent fat in cream	24	23	26.5
Pounds butter fat	5.76	5.52	67.84
Grade of cream, score	89	75	80
Temperature when churned	60°F.	60°F.	56
Temperature of creamery	46°F.	46°F.	50
Amount of coloring used	¼ oz.	¼ oz.	3 oz.
Time required to churn	35 min.	35 min.	35°F.
Temperature of butter	60°F.	60°F.	60°F.
Temperature of buttermilk	60°F.	60°F.	61°F.
Acidity of buttermilk	.84	.86	.88
Amount of salt used	8.75 oz.	7.75	4.4
Per cent fat in buttermilk	.22	.27	.1
Pounds fat lost in manufacture	.03	.04	17
Per cent fat lost in manufacture	.5	.72	.25
Pounds butter made	7	6.2	81
Per cent overrun	22.8	12.3	19.5
Per cent moisture in butter	11.85	10.8	16
Score of butter when made	93	90	91.5
Score of butter by U. S. Dairy Division	93	90	92
Score of butter by Washington Dairy Co	90	80	88
Score of butter by H. W. Shammell	90	82	87
Score of butter by Edel Sons	90	88	89
Average score after reaching the market	90.7	85	89

REMARKS

Dairy Division, Prof. Thompson: "This is fair butter for this time of the year, especially the samples scoring 93. The others have more of an unclean flavor."

Washington Dairy Company: "Part of that would go as firsts and part as seconds on this market. None of it would go in the extra or Elgin class."

Mr. H. W. Shammel: "I would call that firsts and seconds, but would not care to handle any of it."

Edel Sons: "As a whole a very poor lot of butter."

The price of butter on the markets at this time was as follows:

	Baltimore	*Washington*
Extra Creamery	33 to 34	34 to 35
Firsts	31 to 32	32 to 33
Seconds	25 to 26	26 to 27

INVESTIGATIONS AT EASTON CREAMERY

On January 25 the work was taken up at the Easton creamery of Easton, Maryland.

There was no pasteurizer, starter, or even a Babcock tester used in this creamery. The amount of color and salt used in the butter was added according to guess. Milk was paid for by the hundred pounds.

One patron had only pure bred Jerseys, two patrons had only pure bred Holsteins and the others had grade cattle. Several of them watered their milk. All received the same price per hundred for their product.

Many of the patrons had open dairy barns and consequently received a higher score on the points of light and ventilation. The roofs were generally of loose straw, however, and this practically overcame the good effects of such a system. The following represents the score of their dairies and milk. Very little first grade milk being produced it was graded into seconds and thirds, the patrons being grouped accordingly.

GROUP 2

Patron's No.	SCORE *Premises*	 *Milk*	*Bacteria per cc.*
1	46.5	74.6	290,000
3	41.5	79.4	375,000
4	54.5	64.0	380,000
5	50.5	78.2	300,000
8	36	67	350,000
9	57	55	1,290,000
11	59.5	78	400,000
13	47.0	79	890,000
14	44.5	69	400,000
15	53.0	88.6	260,000
16	58.0	81.8	310,000
18	56.5	50.0	1,200,000
Average	50.37	72.05	528,750

GROUP 3

Patron's No.	SCORE *Premises*	 *Milk*	*Bacteria per cc.*
2	37	32.8	900,000
6	42.5	29.8	1,430,000
7	45	66.0	970,000
10	52.5	63.6	720,000
12	41.5	35	700,000
17	30	9	1,520,000
19	36	47.4	960,000
20	39.5	42.0	1,200,000
Average	45.5	40.7	1,050,000

At this creamery also the factory churn was too large to churn less than the entire amount of cream from the milk received at this time of the year. A hand churn was therefore employed in these investigations and the results compared with those of the average factory churnings.

The cream was all ripened at 60° F. at this creamery, churned at 60° F., one-fourth ounce of coloring was used in each churning, twenty minutes were required to churn each, the temperature of the butter and that of the buttermilk was 60° F., and two washings were given with water at 54° F.

CHURNINGS MADE FROM THE DIFFERENT GRADES OF CREAM

	JANUARY 27, 1909		
	2nd Grade Cream	*3rd Grade Cream*	*Mixed Cream*
Pounds cream	15	15	15
Per cent fat in cream	41	36	38
Pounds butter fat	6.15	5.4	5.7
Per cent acid in cream	.4	.45	.49
Grade of cream, score	88	.70	75
Acidity of buttermilk	.7	.58	.65
Amount of salt used	8.4 oz.	6 oz.	6½ oz.
Per cent fat in buttermilk	1	1.5	1
Pounds fat lost in manufacture	.08	.15	.1
Per cent fat lost in manufacture	1.3	2.77	1.75
Pounds butter made	6.75	4.75	5
Per cent overrun	9.75	0	0
Per cent moisture in butter	10	12	11
Score of butter when made	86	87	84
Score of butter by U. S. Dairy Division	86	88	84
Score of butter by Washington Dairy Co	83	85	75
Score of butter by H. H. Butler	84	86	74
Score of butter by Edel Sons	85	87	78
Average score after reaching the market,	84.5	86.5	77.7

REMARKS

Dairy Division, B. D. White: "This is a very poor lot of butter. Nos. 2 and 12 are somewhat better in flavor, but it is all wintry and unclean.

Washington Dairy Company: "A low grade of butter although there is some difference in it."

H. H. Butler: "It is all poor, but there is a big difference between the samples I called firsts and seconds."

Edel Sons: "Very poor butter, but a difference of about nine points between the poorest and the other."

Price of butter at this time:

	Baltimore	*Washington*
Extra Creamery	30 to 30½	30½ to 31
Firsts	25 to 29	28 to 30
Seconds	23 to 24	24 to 25

A COMPARISON OF SOME OF THE FACTORS WHICH INFLUENCED THE QUALITY OF THE BUTTER IN THESE INVESTIGATIONS

The White House creamery produces in the winter an average of 600 pounds of butter per week. Fourteen of the patrons of this creamery were supplying milk of such poor quality that it reduced the price which the butter should bring from one to seven cents a pound. This was a loss to that creamery and to the patrons of from $6 to $42 per week, all because fourteen of its patrons delivered milk which could not be graded as No. 1. That is, when the cream from all the patrons was mixed, the butter produced therefrom generally scored as low as that of Group No. 2 churned separately. For instead of the cream from No. 1 overcoming the defects of No. 2, the cream from the latter being allowed to ripen as it is without pasteurization or the addition of starter, contaminates the cream of Group 1. This was also proved by repeated scoring of the butter from the entire batch of cream during the preliminary part of the experiment. The butter thus made gave an average score of 88.

This low average is probably partially due to methods employed by the buttermaker who was a comparatively new man at the work. The butter made during the experiment was under the supervision of the Experiment Station representative from the time the milk was received at the creamery until the butter was printed.

Pasteurization and the use of starter evidently corrected to a great extent the poor quality of the number two cream at the Harford creamery, for the butter made therefrom in the case of Nos. 22 and 24 2nd grade cream, to which 20 per cent of starter had been added received a higher average score than that from any of the number one cream to which less starter was added. The butter from the 1st grade cream scored higher, however, when the same per cent of starter was added to each grade of cream. A glance at the table showing the per cent of starter used will show the difference. Only 5 per cent of starter was used on the 24th, having been introduced a few days previous by the Experiment Station official in charge, and on the 25th when a sufficient supply was propagated 20 per cent was used in the 2nd grade cream. The Baltimore market scored the butter as a whole lower than the Washington market. The latter judges placed all of the samples except Nos. 3 and 33 in the "Extra" class, with 3 and 33 as seconds and in one instance thirds, making a difference of three to eight cents a pound. On March 27 when the scoring was done in Washington, the market quotations were as follows: Creamery extras 32 and 33, firsts 30 to 31, and seconds 22 to 24. The Baltimore market at this time quoted extras at 32, firsts, 30 and seconds 20 cents. Although the scoring done in this market at this time seems rather inconsistent it is evident that the butter made from second grade cream without the use of starter was far below that from the same cream to which starter had been added. The difference in price on the Baltimore market at that time was ten cents a pound. While as a whole the grading was beneficial the pasteurization and use of starter was still more beneficial,.

One of the most important observations made in this experiment is that of the difference in overrun between first and second cream. The temperature of the wash water and other conditions remained constant, and were not allowed to vary with daily conditions existing at the creamery.

The mixed cream gave an overrun of 10.19 per cent, that of number one gave 12.28 and 18.01 per cent. Number two cream produced an overrun of only 4.86 and 7.54 per cent where starter was used, and no overrun without the use of starter.

This difference in overrun on 900 pounds of cream, the average amount churned at that time, is demonstrated in the following table:

900 lbs. cream 30% fat equals 270 lbs. butter fat.

Overrun 10.19%,	297.51 lbs. butter at 30c.	$89.25	Mixed Cream
Overrun 12.28%,	303.16 lbs. butter at 30c.	90.94	No. 1 Cream
Overrun 4.86%,	283.12 lbs. butter at 30c.	84.93	No. 2 Cream
Overrun 18.01%,	318.63 lbs. butter at 30c.	95.58	No. 1 Cream
Overrun 7.54%,	290.36 lbs. butter at 30c.	87.11	No. 2 Cream
Overrun 0.00,	270.00 lbs. butter at 30c.	81.00	No. 2 Cream— (without starter.)

The per cent of moisture retained in the butter does not bear a constant relation to the per cent of overrun obtained. This is probably due to the fact that milk fats vary in their power to absorb moisture in a liquid state. The better grades of cream, however, appear to be in a condition to retain more fat in the butter produced therefrom and consequently more water, although the per cent of water may not be increased. In the churning of the second grades of cream it will be noticed that the per cent of loss in manufacture was much greater than that of the first grade of cream.

This is a very significant point in the manufacture of a uniform product. Figuring on a uniform overrun 15, 18, 19, 5, 12, and 8 pounds of salt were used in the butter of the churnings at the Cold Spring creamery. The variation of overrun caused the amount of salt per pound of butter to be as follows:

April 18	No. 1, .85 oz. per lb.	No. 2 .85 oz. per lb.	No. 3, .9 oz.
April 25	No. 1, .82 oz. per lb.	No. 2 .87 oz. per lb.	No. 3, .84 oz.

As in the previous experiments we have a variation in the amount of salt used per pound of butter, and for the same reason. The buttermaker did not test his cream each time before churning and was permitted to salt the butter after his usual methods, according to weight of cream, and the variation in the amount of salt per pound of butter is accordingly noted in the table. Uniform butter cannot be made by such a procedure.

The Sparrows Point Store creamery received a poor quality of milk as a whole, but with careful and sanitary methods produced a fair quality of butter. Had the use of starter been employed with their pasteurization a far better and more uniform grade of butter could have been produced. Pasteurization merely destroys the most of the bacteria present in the milk, including all of the lactic acid producing oragnisms. When thus allowed to ripen without the addition of starter from lactic acid culture, a flat flavor is produced and the organisms that have withstood the pasteurizing temperature frequently develop undesirable flavors in the butter.

All of the butter from the Easton creamery scored low. Although some of the milk received was of a very poor quality the conditions there were the least conducive to the correction of any such fault.

A COMPARISON OF DAIRY CONDITIONS ON THE FARMS OF MARYLAND CREAMERY PATRONS

It was interesting to note the remarkable manner in which the farm conditions compared with the score of the milk at the creameries. The milk from farms where the more sanitary conditions prevailed generally scored higher than that from the farms where conditions were less sanitary.

Most of the barns were deficient in light and ventilation, and the manure piles were frequently too near the barn doors. Many of the ceilings were not tight and chaff and dust sifted through. These were the prevailing faults on the farms of the patrons of the creameries in Frederick, Carroll, Baltimore and Harford counties: Among the most desirable conditions was the prevalence of an inexhaustible supply of clear, cold spring water, which upon examination contained an average of only 100 bacteria per cc. With but few exceptions the patrons had spring houses with such water running through them. In some cases, however, vegetables and other objectionable material was kept in the same room with the milk.

Some of the patrons and their help milked with wet hands, some used hot water for rinsing their dairy utensils, but in almost every instance rinsed them again with cold water. This naturally counteracted the sterilizing effect of the hot-water rinsing.

Some of the milk was cooled rapidly by setting the cans in cold water and stirring the milk with a long-handled dipper. Such milk generally scored high at the creamery. Some of the patrons allowed their milk to set in the water without stirring and with the can covers tightly closed. This milk cooled very slowly and invariably had a musty flavor.

In Talbot County the creamery patrons' barns were on the whole more sanitary than those of the other counties previously mentioned. Although some of the barns lacked light and ventilation many of them were open on the south side. Of these, some were almost ideal, for this section, being whitewashed and having tight board roofs. Most of them, however, had only straw roofs which allowed chaff to sift through. All of the dairy farms visited in Talbot County possessed good well water, but few of them had running spring water or spring houses, as did those of the northern counties of Maryland. The patrons were mostly interested in diversified truck farming, with a few cows and a dairy as a side issue.

CREAMERY CONDITIONS, THE CAUSE OF LACK OF UNIFORMITY IN MARYLAND BUTTER

From these results and from personal observation of existing conditions in the dairies and creameries included in these investigations it is obvious that the cause of lack of uniformity in the butter produced in Maryland is due to the lack of proper methods and equipment in the creameries to control seasonal fluctuations in the quality of the milk and cream, or even the variations arising from daily bacterial contamination of a promiscuous milk supply.

Of the five creameries in question only two had pasteurizers. Starter was used in only one of these, after having been introduced by the Experiment Station representative.

Not one of the five buttermakers or managers in charge had any technical training in their line of work. One buttermaker had previously been employed as a motorman on a Baltimore street car; one had been a blacksmith, and the other three had come directly from farms. None of them knew how to control the per cent of overrun, and only one graded the milk and cream and churned each grade separately.

Three of the proprietors kept stores, two of which were so situated as to permit the patrons to do their trading while waiting for their skim milk.

Four of the managers ran huckster wagons and brought country produce such as poultry, eggs, veal calves, etc. The proprietor of the fifth creamery held a county office from which he received his chief income. Their creamery business therefore, consisted of merely a part of their occupation.

Only one of the creameries refused to accept garlic tainted milk while the others made a semblance of butter from any and all grades of milk or cream that was delivered.

At none of the creameries was the milk delivered daily during this season of the year and at three of them it was delivered only twice or three times a week. That is, some of the patrons delivered milk three times a week and the others delivered theirs only twice.

Different degrees of sanitation prevailed at each creamery.

Cream was ripened at temperatures varying from 45° to 80° F. in two of the creameries, from 50° to 70° in two others and from 50° to 60° F. in the other. The practice of pastuerizing the water used for washing butter was in vogue in none of these creameries.

These observations together with the fact that most of the creameries of the State make butter only a part of each year and ship cream the remainder of the year, making no specialty of either, explains the cause of variation in the creamery butter of Maryland.

CAUSES OF POOR QUALITY OF MARYLAND BUTTER

1. As may be seen from the foregoing tables the average score of all grades of milk as it arrived at the creameries was 75.8, the average according to grade was as follows: first grade 86.9, second grade 71.7, and third grade 67.4. These grades of milk were all churned together at four of the creameries, while at only one was it graded and the cream churned separately, making two grades of butter.

2. Three of the creamery managers endeavored to instruct their patrons as to the proper methods of caring for their milk, methods of sanitation, etc. The other two gave no such instructions and from the conditions of their creameries there was no such precedent established there.

3. Garlic was reported in the spring and fall of the year on every farm visited, but was only noticeable at one creamery during the time of these investigations.

The prevalence of garlic in Maryland during the spring and fall of the year is detrimental to the butter produced at these seasons where cows are allowed to run on pasture.

4. There is a lack of proper sanitation on the average Maryland dairy farm, the most deficient points of which were: lack of proper light, ventilation, and cleanliness of dairy barns, milking unclean udders with wet hands, use of unsterile dairy utensils, and improper cooling of milk.

5. There is a lack of technical training in dairy lines among the buttermakers of the State which would enable them to properly grade the milk as it is received at the creamery, pasteurize it, make good starter, properly ripen cream, control their overrun, and instruct their patrons in methods of producing sanitary milk and cream.

6. The majority of the creamerymen of the State are engaged in other occupations and devote only a part of their time to the creamery business.

7. The majority of the creamery patrons are engaged in diversified farming and dairying is only a side issue with them.

SUMMARY OF DATA OBTAINED FROM CREAMERIES

On February 15 inquiries were sent to all of the principal creameries of Maryland and to the commission houses of Baltimore to ascertain their opinion of the butter situation of the State.

Twenty-six replies were received from creamery operators, nine of whom had gone out of business. Three replies were received from commission men.

The answers according to the order in which the questions were sent are as follows:

Question 1. How long has your creamery been in operation?

Answers:

30 years
22 years
21 years
21 years
Six 20 years
18 years
15 years
Three 10 years
6 years
2 years

Question 2. How many patrons or farms do you receive milk from?

The number varied from 3 to 167, the average being 50.

Question 3. Do they deliver milk or cream?

Six answered milk, one cream, and six said both.

Question 4. Do they deliver every day?

Three answered yes, and nine said that their patrons delivered six times a week during the summer and three times a week during the winter. One stated that 90 per cent of his patrons delivered every day and the others three times a week. The last one said that his milk patrons delivered three times a week and his cream patrons only twice a week.

Question 5. Do you make the product into butter, ice cream, or sell cream?

Two answered, "butter;" two, "ship cream;" one, "sell condensed milk;" one, "ice cream;" one, "cream and ice cream;" one, "butter and cream;" one, "milk and cream," and four answered, "butter, cream, and ice cream."

Question 6. Where do you market your products?

Two answered, "Baltimore;" two, "Philadelphia;" one, "Philadelphia and Wilmington;" one, "Baltimore, Washington and Pittsburg;" one, "Chambersburg, Pennsylvania;" one, "Baltimore, Wilmington and Philadelphia;" one, "Middletown, Delaware;" one, "Baltimore, Frederick, Westminster and Walkersville;" one, "home trade;" one, "Baltimore and Philadelphia;" one, "different cities;" and one, "local towns."

Question 7. How much milk or cream do you handle per day?

The answers were as follows:

6000 to 12,000 lbs. milk per day
6000 lbs. milk and cream per day
1000 lbs. milk per day
45,000 lbs. milk per day
1200 to 5000 lbs. milk per day
6000 to 12,000 lbs. milk per day
8000 lbs. milk per day
80 to 240 lbs. cream per day
1000 to 2000 lbs. cream per week, 300 to 600 lbs. milk per day
3000 lbs. milk per day
4000 to 8000 lbs. milk per day
44 lbs. cream per day
1000 lbs. milk, 325 lbs. cream per day
1500 lbs. butter per wk.; 250 per day
2850 lbs. milk and 80 lbs. cream per day.

Question 8. On what basis do you purchase milk and cream; by the hundred or by the fat test?

Nine answered, "By fat test;" two, "by the hundred pounds;" one, "on 4 per cent basis;" and three, "by fat test and per gallon." We suppose that "on the 4 per cent basis" indicates that he pays by the hundred pounds and requires that the milk test 4 per cent butter fat.

Question 9. Does your butter sell for more or less than the standard Elgin butter?

Six answered, "about the same;" three answered, "more;" one, "above standard except in garlic season;" three answered "less;" and one wrote "cannot answer."

Question 10. Do your patrons furnish you with clean, sweet milk and cream of good quality and good flavor?

Five answered, "Yes;" one, "fairly;" one, "yes, as a rule;" three answered, "yes, except in garlic season;" one, "except in hot weather;" one, "some do, others do not;" one, "not many, mostly poor;" one, "need improvement along that line;" two, "We only accept sweet milk."

Question 11. Do you grade your cream and make more than one grade of butter. If so what is the difference in the selling price of the different grades of butter?

Eight answered, "no;" one, "some;" one, "in a way;" one, "in garlic season;" and five did not answer the question. They evidently did not grade milk.

Question 12. What suggestions can you make for improving quality of milk and cream delivered at your creamery?

Many of these answers were in part the same, differing in some particulars. To avoid repetition by quoting each, the answers are all included in the following summary:

Better dairy laws, better cows, better care of cows, milk and dairy utensils, including prompt cooling of milk and scalding of cans and pails. More frequent delivery, skimming thicker cream, enforcement of sanitation, prohibiting manufacture of butter on the farms, refusing to accept unclean milk at creamery, and recommending of silage for dairy cows.

Question 13. What means do you adopt for encouraging your patrons to supply more and better milk and cream?

One answered, "none;" one, "the elimination of colored help;" one recommended the reading of dairy papers; one held an annual farmers' meeting; three paid higher prices for best grade of milk; two encouraged their patrons by argument; one tested individual cows separately for his patrons, thus aiding them in eliminating their poorest ones, and two were giving prompt service and a square deal.

Question 14. Do you pasteurize your milk or cream?

Six answered, "No;" four answered, "Yes;" one pasteurized cream during the entire year; one only during the winter, and one during the summer. Two pasteurized the milk before separating and one pasteurized "Some of it."

Question 15. Do you use a starter for ripening cream?

There were only eleven answers to this question, those not answering were evidently in the negative list. Five answered "No;" five, "Yes;" and one said he used it only in the winter.

Question 16. Do you pasteurize the skimmed milk before it is returned to the farmer?

There were twelve answers to this question, the blank spaces indicating, as in the above, a negative reply. Ten answered in the negative and two in the affirmative. Two pasteurized their whole milk and that sufficed for both.

Question 17. How long and at what temperatures do you hold cream from time of separating until churning?

Only nine answers were received to this question, which indicates that the others kept no record of their methods of ripening cream. The answers were as follows:

Eighteen hours at 55° F.; cool to 55° F., and let sour one day in summer and longer in winter.

"Twenty-four hours at 60° F."

"Two days at 60° F."

"Sixty degrees in winter and fifty-two in summer; about 60° F."

"Churn four times a week in winter and six in summer."

"Separate one day and churn the next morning."

Question 18. At what degree of acidity do you churn your cream?

There were only six answers to this question, the others probably made no acid tests. The following answers were received: "Have never learned that degree;" "Don't know;" "Have no acid test;" "Have never used an acid test, but churn when cream has sharp acid taste;" ".55," and "About .4 or .5."

Question 19. How long and at what temperature do you hold butter from time of churning until shipping?

Only one answer indicated that such temperatures were observed. This answer was "About 50." Five shipped at once, one the next day after churning; one held at lowest temperature obtainable for six to eight hours, and two shipped twice a week in summer and once a week in winter.

Question 20. What quantity of salt and coloring do you use in your butter during the different seasons of the year?

To this question there were twelve answers. Two used color and salt according to demand of their trade; three used one ounce of salt per pound of butter, one used one-fourth to one ounce of salt; one used three-fourths to one and one-fourth ounces per pound and one, "Salted twice, using six pounds each time." Two said they used a little color, one used one ounce color to 40 pounds butter in winter and an ounce to 60 pounds butter in summer. One used one ounce color to 30 pounds butter fat; one used from one-fourth ounce in summer to one and one-half ounces in winter, and one used an ounce to 25 gallons of cream. The gentleman who "Salts twice, using 6 pounds each time" evidently uses 6 pounds of salt per 100 pounds butter, then washes once, and adds another 6 pounds of salt.

Question 21. How many times do you wash your butter, and what is the temperature of the wash water used?

There were only eight answers to this question. Three answered "once;" one indicating the temperature at 54° F. and the others did not give temperature. Three wash their butter twice with water at 55° F., one of these uses ice water in the summer; one washes three times with water at 50° F., and one washes once unless cream is very sour, then he washes twice.

Question 22. Do you pasteurize the wash water before washing your butter?

Only nine answers were received to this question and all were in the negative.

Question 23. What is your average per cent of overrun during the various seasons of the year?

To this question there were but eight answers, indicating that the others did not know what their overrun was. One answered, "It's rather hard to get at, larger in the summer than in the winter." One wrote, "Don't know;" two, "10 per cent;" one, "12 to 16 per cent;" one, "12 to 15 per cent;" one, "10 per cent for milk and 20 per cent for cream;" and one, "15 to 18 per cent."

Question 24. What suggestions could you make for the improvement of the creamery butter of your county?

To this question there were seven answers as follows: "Reading dairy papers and attending farmers' meetings;" "Cheaper labor and better milk;" "Good square talk with the farmers;" "A creamery association pledged to purchase only good cream;" "Get rid of garlic;" "Better cows and milk;" "Pasteurizing cream, prohibiting farmers from making butter, compelling creameries to be kept in a sanitary condition, and a better and more scientific knowledge of the process of butter making."

Question 25. Would a course of instruction in the modern methods of making butter be of value to your buttermaker?

Eight answered in the affirmative, and one wrote "I don't think so."

Question 26. Would your buttermaker attend such a course of instruction if given free either at the Experiment Station or some central location?

Eleven answers were received to this question, nine in the affirmative; one wrote "Do not know," and another wrote "If possible."

Question 27. Where would you suggest as the best place and time to give such a course?

Two answered "Now;" one, "Baltimore or Hagerstown;" two, "In winter, at Frederick;" three, "At the Experiment Station during the winter months;" one, "At Hagerstown in May or June;" one, "At the Calvert High School;" and one, "Any time and anywhere."

The three replies from the Baltimore commission men are as follows:

Question 1. Do you handle the product of Maryland creameries or home dairies?

All answered "No."

Question 2. If not, why ?

1. "I cut it out several years ago when the artificial article was at its best." 2. "This is merely a distributing plant, our own make being shipped from the West." 3. "Use only Pennsylvania products."

Question 3. Approximately how much Maryland butter do you handle monthly?

All answered "None."

Question 4. What season of the year do you handle most of the Maryland product?

One answered "Did handle it in May, June and July."

Question 5. What are the defects you notice in the Maryland product and what do you consider causes them?

One answered, "Garlic and grass in the spring and the color used the rest of the year."

Question 6. At what season of the year are the defects most apparent?

One answered, "May, June and July."

Question 7. Have you ever given your patrons advice or instruction for improving their product?

One answered in the affirmative.

Question 8. How was the advice received and with what results?

One answer, "Not heeded."

Question 9. Give all the suggestions you can for the betterment of Maryland butter and the improvement of the creamery industry.

No answers were received to this question.

LIST OF CREAMERIES

This list of creameries is no doubt incomplete, but it is as nearly accurate as it could be made at this date. Any person who knows of a creamery not on this list will do a favor by advising the Experiment Station of the name and location of the same.

Baltimore County

1. White House Creamery Company, Upperco, Md.
2. Monkton Creamery, Monkton, Md.
3. Walnut Grove Creamery, Beckleysville, Md.

Caroline County

4. Enterprise Creamery, Preston, Md.

Carroll County

5. Winfield Creamery, Winfield, Md.
6. Taneytown Creamery, Taneytown, Md.
7. Myers & Arthur Creamery, Frizzellburg, Md.
8. Greenmount Creamery, Greenmount, Md.
9. Cold Spring Creamery, New Windsor, Md.
10. Hampstead Creamery, Hampstead, Md.
11. Norman Creamery Unionville, Md.
12. Harmony Creamery, Sylmar, Md.
13. York Road Creamery, York Road, Md.
14. Mt. Pleasant, Westminster, Md., R. F. D.
15. Melrose Creamery, Westminster, Md.
16. Mt. Airy Creamery, Mt. Airy, Md.

Queen Anne County

17. Centerville Creamery, Centerville, Md.
18. Millington Creamery, Crumpton, Md.

Cecil County

19. Warwick Creamery Co., Warwick, Md.
20. Elkton Creamery, Elkton, Md.
21. Chesapeake City Creamery, Chesapeake City, Md.
22. Bethel Creamery, Pivot, Md.
23. Lombard Creamery, Lombard, Md.

Dorchester County

24. Enterprise Creamery Company, Hurlock, Md.
25. Enterprise Creamery, Ellwood, Md.
26. East New Market Creamery, East New Market, Md.

Frederick County

27. Emmittsburg Creamery, Emmittsburg, Md.
28. Cramer's Creamery, Walkersville, Md.
29. Liberty Creamery Company, Libertytown, Md.
30. The Oyster Creamery Company, Walkersville, Md.

31. Le Gore Creamery, Le Gore, Md.
32. Mountain City Creamery, Frederick, Md.
33. Sparrows Point Store Company, Creamery Mt. Pleasant, Md.
34. Shank Bros. Creamery, Middletown, Md.
35. Buckeyestown Creamery, Buckeyestown, Md.
36. Knoxville Creamery, Knoxville, Md.

Harford County

37. Harford Creamery Company, White Hall, Md.
38. Upper Crossroads Creamery, Upper Crossroads, Md.
39. Salem Creamery, Fallstown, Md.
40. Gilt Edge Creamery, Pylesville, Md.
41. Jerrettsville Creamery, Jerrettsville, Md.

Kent County

42. Kennedyville Creamery Company, Kennedyville, Md.
43. Massey Creamery, Massey, Md.
44. Worton Creamery, Worton, Md.
45. Clendaniel & Company's Creamery, Kennedyville, Md.

Talbot County

46. Easton Creamery Company, Easton, Md.

Washington County

47. Maugansville Creamery, Maugansville, Md.
48. Mountain View Creamery, Smithburg, Md.

SUGGESTIONS FOR OPERATING AN AVERAGE MARYLAND CREAMERY

1. Secure Competent Buttermaker

The first step after a creamery is built is to secure a competent buttermaker who has completed a dairy course at some good dairy school. Such a man will be helpful in securing and arranging the creamery machinery and apparatus as follows:

2. Arrangement of Machinery

Have weigh-can conveniently arranged on scale at delivery platform, a tin spout so adjusted as to run the milk into either of two vats, one for first and one for second grade milk. A pasteurizer and cream separator should be placed near these vats where the best grade of milk may be pasteurized and separated first and the second grade immediately after. A double cream ripening vat containing a coil of pipes for warm and cold water should be placed near enough to the separator to receive the cream, which may be conducted into either division according to grade.

A starter-can should be placed convenient to the ripening vats from which the cream enters, the spouts or gate valves of the vats being on the ends near the churn. A space for the butter printer should be made on the opposite side of the churn, and beyond that the refrigerator or cold storage room. This arrangement of the creamery machinery may be in a line or in circular form to suit the convenience of the building, providing the building has not been made so as to suit the arrangement of the machinery it is to contain. The wash tank with water and steam connections may be arranged in the most convenient place, where shelves are placed for drying creamery apparatus after steaming. A supply of pipe wrenches and other necessary tools should be placed in a convenient place in the boiler, engine, or test room.

A Babcock tester and acid tester with sufficient glassware should be arranged in a small test room where the temperature may be regulated. All minor apparatus should be arranged with a view to convenience.

Ample light and ventilation should be provided.

The following conveniences may be installed with profit at the option of the buttermaker and the financial condition of the proprietors.

Creamery Conveniences

A large fan to keep the air fresh and the flies out.

A low-water whistle alarm on the boiler as required by law in some states.

A cord connected to the safety valve on the boiler and stapled around the periphery of the creamery, with a weight attached sufficient to pull the valve open if the cord is ever burned in two. In case of fire the steam and hot water will aid materially in extinguishing it.

An automatic scale to show the weight of the milk as soon as emptied into the can.

The butter printing table fastened on the wall, with hinges and drop legs.

Pipe brushes with sectional handles to clean milk pipes.

A heater regulator to control the temperature of milk when separating; also cream when pasteurizing.

Steam and water connections with hose to wash vats, walks and floor.

Cases for separator and pasteurizer parts hung neatly on the wall near the machines.

A case similar to the above for a complete set of creamerymen's tools.

An oil cloth to cover the engine, separator, and pasteurizer when not in use, to keep off the dust.

3. Grading Milk

As the milk arrives at the creamery refuse to accept all sour milk, or any which is unfit for human consumption. Weigh milk promptly, place samples in composite sample jars, and grade each lot by taste and smell. It requires time to learn to grade milk accurately, but a cultivated taste is gradually acquired, and most buttermakers learn to grade milk in a few weeks' time.

4. Operating Creamery

The pasteurizer and separator should be started as soon as there is a sufficient amount of the best grade of milk on hand to insure a continuous run until all of the patrons arrive. Heat milk to 170° F. in a continuous pasteurizer and cool to 85° F. before it enters the separator. This rids the cream and also the skimmed milk of most of the undesirable bacteria, including all tuberculosis germs. This, together with washing and steaming the patrons' cans before filling them with skimmed milk, would prevent the spread of tuberculosis or most other infectious diseases. The importance of such pasteurization cannot be overestimated since hogs have been found to be more susceptible to tuberculosis than any other domestic animal.

Ridding the cream of the majority of the bacteria present leaves a comparatively clean field for the lactic acid bacteria which are added in the starter to produce a good and uniform flavor in the butter from day to day.

After pasteurizing and separating the best grade of cream should be allowed to run into one division of the cream ripening vat and the second grade into the other division. It should be cooled to 70° F. by revolving the coils containing cold water. At this temperature the starter should be added and the cream allowed to ripen. The best flavor is produced in butter from cream ripened at this temperature.

From 10 to 30 per cent of starter should be added, depending upon the acidity of the cream as it reaches the ripener and the length of time it is to remain there before churning. Cream is usually churned the following morning after it arrives, and where this method is practised should be ripened at 70° F. to about .4 per cent acid and gradually cooled to 50° F. over night.

Stir cream occasionally to insure uniform ripening.

Making Starter

Starter is made by sterilizing a clean flavored batch of sweet skimmed or whole milk by running it through a pasteurizer and heating to about 212° F., preferably two days in succession. Allow some of the milk to run into a sterile quart bottle. Cover bottle as soon as full and cool to 88° F. Add contents of capsule or bottle of commercial culture of lactic acid bacteria and allow to remain at 80° F. until it becomes partially thickened, or has the consistency of thick cream. This usually requires from eight to twelve hours. Pour from the top of the bottle into the starter can containing from five to ten gallons of pasteurized milk the contents of the bottle with the exception of about a teaspoonful. Put the spoonful of starter remaining in the bottle into a clean sterile bottle and add enough pasteurized milk to continue the propagation of original culture, being careful thereafter to hold at 70° F. for a few hours. Then cool to a low temperature or it will become over ripe and whey off.

Having been ripened and cooled to 50° F. during the night the cream should be churned at that temperature in the summer and at about 55° F. in the winter.

The method of churning sweet cream, described on page 274 will be found feasible for many buttermakers.

A sample of cream should be tested for butter fat, so as to accurately calculate the amount of butter obtainable and to know exactly how much salt to use. The testing may be most conveniently done for each churning on the afternoon of the day previous to the churning.

Also make an acid test of the cream at this time so as to regulate the acidity and have it uniform from day to day.

Weigh or measure the cream as it is put into the churn and calculate the amount of butter fat as follows:

Example

500 × .30 = 150 + 6 = 25	500 lbs. cream,
25 + 150 = 175 lbs. br.	30 per cent fat,
	6)150.0 butter fat.
	25 overrun at 16.6 per cent
	175 butter
Using 1 oz. salt per lb. butter	16)175 oz. salt.
	10.9 lb. salt.
Color in winter 1 cc. per 2 lbs. butter fat,	2)150 butter fat.
	75 cc. color.

Where measuring is more convenient than weighing the following standard weights may be used:

1 gallon cream testing 15 per cent fat weighs 8 pounds 7 ounces.
1 gallon cream testing 20 per cent fat weighs 8 pounds 6½ ounces.
1 gallon cream testing 25 per cent fat weighs 8 pounds 6 ounces.
1 gallon cream testing 30 per cent fat weighs 8 pounds 5½ ounces.
1 gallon cream testing 35 per cent fat weighs 8 pounds 3 ounces.
1 gallon cream testing 40 per cent fat weighs 8 pounds 1 ounce.
1 gallon cream testing 45 per cent fat weighs 7 pounds 15 ounces.
1 gallon cream testing 50 per cent fat weighs 7 pounds 14½ ounces.

Before churning each morning rinse churn with hot water from 150 to 200° F., revolve it from five to ten times, being careful to leave stopper out. Draw off water and rinse again in the same manner with pure cold water at about 50° F., leaving stopper in during last rinsing. Draw off water and pour the ripened cream in, filling churn about one-third full, so as to allow the greatest splash when churning. Add vegetable coloring the amount depending on the time of the year and market requirements. Put cover on tight and set churn in motion, removing stopper two or three times during the first part of the churning to allow the moist air to escape.

When the butter has gathered in granules the size of number 4 to 00 shot stop churn and draw off buttermilk. Rinse once using one-quarter of the churnful of sterile water (water which has been boiled and cooled) about the same temperature of the butter, revolving churn about three times. Draw off and if rinse water still has milky color rinse again. Otherwise not. Add salt depending on your market requirements. Keep salt in dry place and for best results it should not be colder than butter when added. Salt must be distributed evenly to prevent mottling in butter. This is best done as follows: Pulverize salt and distribute as evenly as possible. Throw workers into gear, using low speed. Revolve churn about ten times and allow to stand for twenty minutes to give the salt a chance to dissolve evenly. Work ten revolutions more, take out, and print or pack in cases or tubs which have been previously scalded and coated on the inside with paraffin.

Prints should be cut with square corners and neatly wrapped. Tubs should be lined with circles and liners that have been previously soaked about twelve hours in a cool brine solution to destroy mould and undesirable bacteria.

Calculate the per cent of overrun as follows:

Example

175 − 150 = 25
25 × 100 = 2500 ÷ 150 = 16.6 per cent

175 lbs. butter.
150 lbs. butter fat.
25
100
150)2500(16.6 per cent
150
1000
900
1000
900

Percentage of overrun	*Pounds overrun on 100 b. butter fat*	*Value of overrun at 25c. per lb.*
20	20	$5.00
18	18.0	4.50
16	16.0	4.00
15	15.0	3.75
13	13.0	3.25
9	9.0	2.25
5	5.0	1.25

The overrun may be controlled to a great extent by the temperature of the butter and the temperature of the water used. The warmer the butter the more water it will absorb providing the water is not too cold.

Washing butter with very cold water, below 50° F. chills the grain causing it to contract and expel moisture, consequently producing a low overrun.

For best results the temperature of the butter should range between 50° and 60° F. when churned (50° to 55° F. in the summer and 55° to 60° F. in the winter) and the wash water should be within one degree of the temperature of the butter when washed.

The incorporation of too much water is both detrimental and unlawful. The legal moisture limit is 16 per cent.

Keep butter in cold storage until ready to ship and ship in refrigerator cars if possible. Samples of the skim milk and buttermilk should be tested daily, and the loss of fat reduced to a minimum.

A butter maker should be absolutely accurate in the use of the Babcock test, sampling milk, keeping books, and should be able to instruct his patrons in methods of sanitation in handling their milk, proper balancing of rations for dairy cows, and general dairy management for obtaining best results.

SUGGESTIONS TO CREAMERY PATRONS

It is impossible to make first-class butter out of tainted or otherwise defective milk. It is possible under Maryland conditions to send cold, sweet, first grade milk to your creamery at all times during the year. No State in the Union possesses a better supply of clear, cold, spring water. It is only necessary to observe a few simple rules of sanitation in order to produce the best grade of milk. Thoroughly wash all dairy utensils with some good washing powder each time after using, and then rinse with boiling hot water to destroy all germs. Expose them to direct sunlight during the day when weather permits. Brush each cow's side and udder with a damp cloth or sponge before milking. Milk with clean dry hands. Discard the first stream of milk from each teat so as to rinse any invisible dirt out of the teat duct. Cool each cow's milk in pure atmosphere immediately after milking. This may be done by use of cooler and aerator placed in the spring house, or by placing in a narrow can surrounded by cold water, and stirring the milk with a long-handled dipper or stirring rod. A boy may carry each cow's milk to the spring house as fast as they are milked and return the empty pails as others are filled.

No vegetables, meat or anything that will impart an odor or flavor to the milk should be kept in the milk room.

After the milk is cool place covers tightly on cans and keep as cold as possible until delivered. During the summer use wet gunny sacks or heavy blankets to cover cans enroute to the creamery. See that your cans are washed and steamed at the creamery before filling with skim milk. Insist on having the skim milk pasteurized so as to prevent contamination from tuberculosis.

Keep your dairy barn clean, whitewashed, light, and well ventilated. See Government score card for amount of light necessary.

Feeding and bedding of cows should be done after milking, as the dust contains bacteria that spoil the milk.

Milk is one of the best foods for bacteria and the undesirable germs grow rapidly in this fluid while warm. Therefore, keep them out as far as possible by sterilization and cleanliness, and then cool the milk immediately after milking to check the growth of those that do find their way into it.

SUGGESTIONS FOR BUTTER MAKING ON THE FARM

When butter is made on the farm the same rules as given for creamery butter making in the foregoing pages of this bulletin will apply in a general way.

Cream should be ripened at about 70° F. and if possible with a starter from lactic acid culture as previously described. Home-made starter may be used if care is exercised in making. Use perfectly clean skimmed, or whole milk which has been allowed to sour in a sterile, well-covered can at 70° F. Starter is nothing but a clean flavored batch of sour milk. When thickened to the consistency of thick cream it is ready to use. Starter should not be added when overripe (wheyed off), as the lactic acid forming bacteria will be inactive and the curd will appear in white specks in the butter.

Any small can with a tight-fitting cover may be substituted for a starter can. When cream begins to turn sour it should be cooled to 50° F. and held at this temperature until ready to churn. This gives the butter a firm texture when churned.

Rinse churn with hot water, then with pure cold water if in summer. In winter the cold water rinsing is unnecessary. Place cream in the churn at about 55° F. in the summer and 60° F. in the winter. Add color to suit taste. Fill churn about one-third full and turn crank at speed which will allow the greatest splash in churning. Stop churning when butter granules are about the size of a wheat grain. Draw off buttermilk. Rinse butter with pure cold water until rinse water runs off almost clear. Salt may be added to suit taste; an ounce per pound of butter is usually sufficient. Work salt in by pressing butter worker or paddle straight down without drawing it over the surface. Where a paddle is drawn across the surface of the butter the grain is not only spoiled but the butter has a greasy taste and appearance. Pack well, exclude as much air from the jar as possible by use of clean damp cloths and keep in the coldest place on the farm.

INVESTIGATIONS IN THE MANUFACTURE OF SWEET CREAM BUTTER

The growing demand for sweet cream butter for fancy trade in many of our large cities, the economy of labor derived from churning sweet cream, thus eliminating the process of cream ripening, and thereby reducing the danger of the development of undesirable bacteria and further contamination during the process, suggested the following experiments:

1. Churning normal sweet cream in comparison with ripened cream.
2. Churning normal sweet cream to which starter has been added.
3. Churning sweet pasteurized cream to which starter has been added.
4. Churning sweet cream to which commercial lactic acid has been added as a substitute for starter.
5. The addition of lactic acid to butter in the churn and working it in.
6. The addition of warm skimmed milk as a substitute for heating cream to churning temperature during cold weather.

In these investigations starter was made from skim milk in the usual way as described on page 264. Starters were also made from whole milk and cream, and the results obtained by their use compared.

Natural starter was also used in comparison with starter made from commercial cultures.

Natural starter is made by allowing a clean, flavored batch of milk to sour and thicken to a creamy consistency by the normal process at about 70° F. The chief difference between natural and commercial starter lies in the fact that the latter contains practically a pure culture of lactic acid bacteria while the former contains many other germs which reduce their effect, and frequently produce undesirable flavors.

All starters were used and propagated similarly after making.

Experiments were also made by adding lactic acid directly to cream and by adding it directly to butter in the churn and working it in.

Pasteurization was effected by heating at from 150 to 180° F. and cooling immediately. Also by maintaining these temperatures for twenty minutes.

To determine the effect of pasteurizing temperatures on the bacterial content of cream, plate cultures and acid tests of the cream were made after pasteurizing at various temperatures with the following average results:

TABLE I

	Bacteria per cc.	*Acid content at the end of 24 hours at 60° F. Per cent acid.*
Normal unheated cream	25,000	.67
Cream pasteurized at 180° F. not cooled	1,000	.3
Cream pasteurized at 180° F. cooled to 80° F.	150	.28
Cream pasteurized at 180° F. cooled to 50° F.	30	.25
Cream pasteurized at 170° F. not cooled	1500	. 3
Cream pasteurized at 170° F. cooled to 70° F	200	.29
Cream pasteurized at 170° F. cooled to 50° F	45	.26
Cream pasteurized at 150° F. not cooled	4000	.3
Cream pasteurized at 150° F. cooled to .50° F	250	.29

As illustrated by the above table immediate cooling proved a very important part of pasteurization in reducing the germ content of the cream, especially when the pasteurizing temperatures did not exceed 150° F.

Exposure to sudden changes of temperature destroyed or inhibited the bacteria almost as readily as did the heating alone. Doubtless some of the bacteria in the cooled cream were obtained from the air during the process of cooling. Pasteurization checked the development of acid in cream by destroying the lactic acid bacteria present.

The investigations were conducted from January 1, 1907, to January 1, 1909, a churning being made from one to four times a week for several weeks during every season of each year. The results of the investigations were therefore obtained from observations taken from 125 churnings. The cream used in this work, with the exception of experiments conducted at the Mt. Pleasant creamery, was obtained from milk of the Station herd, milked in Gurler sanitary milk pails, and separated and churned as soon as properly cooled (held at 50° F. or below for at least two hours). The average score of the cream obtained from the Station herd during this period was 96. This must be borne in mind in considering the greater differences resulting from the use of a low grade of cream. This also accounts for the higher average scores of butter from the Station cream than from that of the creamery.

The cream was graded on the basis of the following points:

PERFECT SCORE

Flavor:		*Condition:*	
Taste	30	Cleanliness	20
Smell	30	Acidity	20
Total			100

In all of the investigations the water used for washing butter was boiled and then cooled so as to prevent contamination from that source.

The scoring was all done by experts, the U. S. Dairy Division frequently furnishing judges for this purpose.

The average score of the butter made by the various methods, together with the loss of fat in the buttermilk when churned under identical conditions during the two years, is illustrated in the following table:

TABLE II.

Ripened Cream in These Tables Indicates Souring Until it Contains From 0.5 to 0.6 Per Cent of Lactic Acid.

SWEET CREAM (containing 0.2 per cent acid; average score 96.)

		SCORE OF BUTTER.				PER CENT FAT IN BUTTERMILK.		
		Pasteurised at			Unpasteurised.	Churned below 48° F. and warm milk added.	Churned at 50° F.	Churned at 55° F. to 60° F.
		180° F.	170° F.	150° F.				
						per ct.	*per ct.*	*per ct.*
Cream starter used	Added to cream and ripened	94	94	94.5	92.9	.1	.11	.3
	Added to cream 2 hours before churning ...	95	95	95.5	93.4	.15	.18	.89
Whole milk starter used	Added to cream and ripened...........	93.8	94	94.4	92.2	.1	.12	.32
	Added to cream 2 hours before churning ...	95.5	95.5	95.6	93	.16	.2	.88
Skim milk starter used	Added to cream and ripened	94	94	94.2	92	.1	.12	.3
	Added to cream 2 hours before churning ...	94.3	94.5	95	93.5	.15	.2	.9
Natural starter used	Added to cream and ripened...........	92.8	93	93	93	.14	.15	.35
	Added to cream 2 hours before churning....	92.5	92.7	93	92.5	.16	.17	.9
Commercial lactic acid used	Added to cream when put into churn	91	91	91	90	.2	.28	.9
	Added to butter and worked into it	91	90.0	91	90	.4	.45	1.5
Check churnings	Churned sweet without starter.	89.5	90	90	90.4	.4	.45	1.5
	Ripened normally without starter				90.6	.15	.18	.4

TABLE III.

Mixed Cream of Creamery Supply

Average Score 70, acidity .3 per cent.

		SCORE OF BUTTER.				PERCENT OF FAT IN BUTTERMILK.		
		Pasteurized at						
		180° F.	170° F.	150° F.	Unpasteurized.	Churned below 48° F. and warm milk added.	Churned at 50° F.	Churned at 55° F. to 60° F.
						per ct.	*per ct.*	*per ct.*
Cream starter used	Added to cream and ripened	91.4	91	91	90	.16	.17	.4
	Added to cream 2 hours before churning	93	93	92	91	.2	.22	.9
Whole milk starter used	Added to cream and ripened	91	92	91	90	.16	.16	.4
	Added to cream 2 hours before churning	93.7	94	93	90.7	.2	.23	.95
Skim milk starter used	Added to cream and ripened	92.5	91.9	91	89.5	.17	.18	.41
	Added to cream 2 hours before churning	93.5	93.2	93	91	.22	.23	.98
Natural starter used	Added to cream and ripened	89.5	89	88.6	88	.2	.21	.45
	Added to cream 2 hours before churning	91	90.9	90	88.1	.29	.32	1.1
Commercial lactic acid used	Added to cream when put into churn	90	90	90.1	89	.25	.25	1.3
	Added to butter and worked into it	90.1	90.2	90.2	89.5	.45	.5	1.8
Check churning	Churned sweet without starter	87	87.4	87.5	86	.45	.5	1.8
	Ripened normally without stater				85	.21	.25	.45

The averages in the above tables indicate that the butter made from cream which had been pasteurized at 150° F. averaged slightly higher in Table II than that which had been made from cream pasteurized at 185° F., and slightly lower in Table III. This is probably due to the fact that the cream used in Table II instead of being run through a continuous pasteurizer was held for 20 minutes at the temperature at which it was pasteurized, while a continuous pasteurizer was used for the cream of Table III. Holding the cream at high temperature for twenty minutes, or longer, seemed to have a detrimental effect on both the texture of the butter and its keeping qualities.

Immediate cooling proved to be a very important part of the pasteurization, not only in the texture of the butter produced from such cream, but also in the destruction of the bacteria present.

The texture of the butter once destroyed could never be entirely restored by cooling.

The butter made from the best unpasteurized cream when commercial starter was added averaged 92.8 per cent. That of the same kind of cream without starter, 90.1 per cent. A far greater difference is observed in Table II where a poorer grade of cream was used. The keeping quality of the butter was also much better when starter was added. A decided difference is noted between the butter made from natural and commercial culture starters. Natural starters, although carefully selected were very seldom equal to the starters made from commercial cultures, and butter made from cream ripened by them lacked the aroma and keeping qualities of the commercial starter butter.

Cream starters, the use of which eliminates the dilution of cream, proved almost as satisfactory as skim or whole milk starters, 20 per cent cream being used for this purpose. Skim milk starters are beneficial where a heavy cream can be obtained, but in hand separator districts this is not always the case. In fact, some buttermakers experience a great deal of difficulty in obtaining cream that will test higher than 25 per cent. In such instances a 30 per cent or 35 per cent cream starter brings the cream to the proper fat content for churning, while a skim or whole milk starter makes it entirley too thin for best results.

The butter made from cream to which cream starter had been added scored from 92 to 98 and had a good but mild flavor. Skim and whole milk starters, however, usually contained more of the characteristic sharp acid taste. When any of the starters had a flat taste they failed to impart the desired flavor to the butter. Best results were obtained, with starter which contained from .9 per cent to 1.0 per cent of acid and possessed the desired flavor in a pronounced state. In view of the fact that lactic acid forming bacteria develop more readily in cream than in butter, it is more important that starter contain the proper acidity and flavor when added to cream only two hours before churning than when added to cream for ripening. There was less tendency to produce mottles, however, when starter of more than 1 per cent acid was added to cream only two hours before churning. When overripe starter (clabbered until it begins to whey off) was used it formed little white specks in the butter. The acidity also became so high at this point that it destroyed many of the lactic acid bacteria present.

It was found that when starter was added to cream in the churn it failed to impart sufficient flavor and aroma to the butter. Adding the starter immediately after pasteurizing and allowing the cream to cool for at least two hours, during which time it was frequently stirred, permitted the lactic acid bacteria to penetrate the fat globules and thus impart and continue to develop the desired flavor to the resulting butter. Much better results were obtained by the use of pasteurized than with unpasteurized cream by this method.

The amount of starter to be added to cream when churned before ripening, depends upon the acidity of the cream and starter used. The formula adopted by the Guelph Agricultural College of Ontario, Canada, who advocate the method, proved very satisfactory:

SUMMER MAKE

	Per cent.
Acidity of cream	.14
Acidity of starter	1.00
Quantity of starter to be used	.20

WINTER MAKE

Acidity of cream	.14
Acidity of starter	1.00
Quantity of starter to be used	.30

The product of these standards divided by the acidity of the cream and the starter on hand will give the required per cent of starter to be used. Ex.—For summer churning: if the acidity of the cream to be churned is .15 per cent and that of the starter .9 per cent, then; $\frac{14 \times 1.00 \times 20}{.15 \times .9} = 20.74$ per cent starter to be added to the cream.

The use of commercial lactic acid as a substitute for starter proved less satisfactory than good starter, although some of the butter to which it was added scored as high as 94 per cent when made. Its keeping qualities however were not as good as those of the butter from starter ripened cream. It did not have the characteristic strong rancid flavor of normally made improperly stored butter, but a very stale, unpleasant flavor and odor peculiar to itself. Butter made from cream to which lactic acid had been added lacked aroma and had a musty stale taste if more than 3 cc. acid was used per pound of cream. This butter showed less tendency to mould, however, than the check samples where acid was not used.

Buttermilk from sweet cream where no starter had been added was very flat and thin. It was not improved where commercial lactic acid had been substituted for starter. The lactic acid gave it a sour, but also a stale, acid taste. The per cent of acidity increased as readily in the buttermilk from the cream to which lactic acid had been added as in that to which no acid had been added, showing that this acid when added in such small quantities has no appreciable effect upon the growth of lactic acid bacteria. Commercial lactic acid for this purpose (22 per cent) costs 4 cents a pound, f. o. b., Bradford, Pa. The expense therefore is of little consequence.

Sweet cream butter required from one-fourth to one-half ounce more salt per pound of butter than did that of ripened cream. The flavor was also improved by the use of this increased amount of salt, while the aroma remained unaffected.

Butter from cream having a rancid or otherwise "off flavor" was improved from one to three points by washing two and three times (until the rinse water from it was perfectly clear) with pure water and then working commercial lactic acid into it at the rate of 10 cc. to every 5 pounds of butter. The aroma however was usually reduced. The acid was best absorbed by the butter at temperatures above 55° F. The advantage of this system lies in the fact that where pasteurization cannot be done the undesirable flavors may to a certain extent be washed out and some of the desired flavor worked in. In this method there is little danger of excessive washing, as the flavor is in part restored by the addition of lactic acid. Where pasteurization is done still more of the proper flavor may be added to the butter by this method.

A few experiments were also made by adding starter to the butter in the churn and working it in. While practically as much improvement was produced in the flavor by this method as by the addition of lactic acid in a similar manner, the butter was always milky and usually mottled.

The results as will be noticed by the tables show a marked difference in favor of sweet cream churning over that of cream ripening. The average score of all butter from ripened cream in Table III was 90.4. The average score of all butter from the same cream churned after starter had been added only two hours was 95. As far as could be ascertained this difference was due to the effects of undesirable contamination during the process of ripening and handling. Contamination increased with the rise of temperature.

The results as indicated by the tables show a decided difference in the amount of fat lost in the buttermilk from cream churned at different temperatures.

Far more exhaustive churnings were made by churning cream at 50° F. and below than at higher temperatures. The total average percentage of loss of fat in the buttermilk from all cream churned at 48° F. or below was .19 per cent, that of cream churned at 50° F. was .22 per cent, and that of cream churned at from 55° F. to 60° F. was .76 per cent.

During hot weather when small quantities of cream were held at 50° F. for two hours and churned, a considerable amount of fat was lost in the buttermilk. When it was held at lower temperatures, 2½ to 3 hours however, the fat globules became chilled and a much smaller per cent of loss of fat as well as a firmer body resulted. Where the amount of cream churned equaled 25 gallons or more, it did not warm up so rapidly when churning. The smaller the amount of cream the less time required to change its temperature to that of the room in which it is churned. When cream testing less than .2 per cent acid was churned above 50° F. the loss of fat in the buttermilk was proportional to the temperature. The higher the temperature the greater the loss.

When the cream was churned at 48° F. or below the butter failed to gather until the temperature was raised. After churning at this temperature however for 45 minutes to an hour it acquired a somewhat viscous state where upon heating to 50° F. to 60° F., by the use of warm skim milk, or water, the butter gathered almost instantly. two to five revolutions of the churn usually being sufficient to bring it to the proper sized granules. This seems to have solved the problem of sweet cream churning, for the loss of fat in the buttermilk by this method (when starter is used in the cream) was as low or lower than that of sour cream churning. Almost equally exhaustive churnings were made where sweet cream was churned at 50° F., but it required an appreciable amount of ice in summer and steam in winter, also a great deal of the buttermaker's time to obtain this temperature and maintain it while churning.

The advantage of this hot skim milk method is that of being able to churn at any temperature that the cream happens to be when the buttermaker is ready to churn. If it is 50° F., or above, no hot milk need be added. Butter cannot be over-churned by this method, and the body and grain produced by churning at these low temperatures is remarkably good, provided the temperature is not raised above 56° F. by the addition of warm milk. When these temperatures were exceeded the grain and body of the butter was not only injured, but a loss of fat in the buttermilk resulted. The addition of enough warm skim milk or pure warm water to raise the temperature to 56° F. did not materially affect the body of the butter, in view of the fact that fat is a non-conductor of heat and is heated more slowly than the milk serum. Warm skim milk is preferable for this purpose, as it does not dilute the buttermilk.

The addition of warm milk or water exposed the butter of 45° F. to a temperature of 56° F. for one to three minutes only. During this time the temperature of the butter raised from one to two degrees.

For average creamery conditions where the natural temperature is low in winter and high in summer it is advisable to churn at the most convenient temperatures below 60° F. thereby effecting the greatest possible economy of fuel and ice. In cold weather cream may therefore be churned at from 35° F. to 48° F. with the addition of warm skim milk as above described whenever it is desired to have the cream "break." In warm weather cream under average creamery conditions should be churned as soon after reaching the creamery as convenient. If churned without the use of starter or above 53° F. the buttermilk should be passed through the separator and the cream thus obtained should be rechurned.

Where a creamery is supplied with a sufficient amount of ice or refrigeration the above method (churning at 48° F. or below) could be adopted throughout the entire year. In this method the amount of skim milk of a given temperature required to raise that of cream of a given temperature as desired may be found as follows:

Let t = temperature of skim milk, t^1 = temperature of cream, and t^2 = temperature of the mixture. .86 equals the specific heat of skim milk and .78 the specific heat of 30 per cent cream

Sp. heat of cream, .78
Sp. heat of skim milk, .86
t temperature of skim milk
t^1 temperature of cream

t^2 temperature of mixed milk and cream
S skim milk
C cream

Ex. Where 200 pounds of cream at 45° F. are to be raised to 56° F. with skim milk at 150° F:

$$\begin{aligned} S \times .86 \times (150 - 56) &= 200 \times .78 \times (56 - 45) \\ S \times 80.84 &= 1716 \\ 80.84S &= 1716 \\ S &= 21.22 \text{ pounds of skim milk to be added.} \end{aligned}$$

The following table was designed for the use of buttermakers and dairymen who desire to adopt this method of churning. The table is constructed without regard to temperature of vats or creamery. Allowance should be made for this.

The numbers in the left-hand column indicate the pounds of cream to be churned; the temperature of the cream is indicated by the top row of numbers. The temperature of the skim milk is 150° F. for convenience. This temperature being most practical for all conditions, as is also 56° F. for the desired temperature of mixture when cream "breaks."

In the use of this table trace the row of figures on the horizontal line from the number of pounds of cream to be churned, until it intersects the vertical row of figures from the temperature of the cream in question. The figure at this point represents the number of pounds of skim milk at 150° F. that are required to raise your cream to 56° F.

For example: we have 200 pounds of cream at 40° F. and after churning half an hour wish to bring the butter. Trace the horizontal line from 200 to where it intersects the vertical line from 40° F. The number at this point is 30.87. Therefore it requires 30.87 pounds of skim milk at 150° F. to raise the temperature of 200 pounds of cream at 40° F. to 56° F.

$$\begin{aligned} S \times .86 \times (150 - 56) &= 200 \times .78 \times (56 - 40) \\ S \times 80.84 &= 2496 \\ S &= 30.87 \end{aligned}$$

It will be noticed in this table that the rate of difference is not exactly constant between the number of pounds of skim milk required to raise a given number of pounds of cream of various temperatures to 56° F. This is due to the fact that only hundredth places were used. Had

Amount of skim milk required to raise a given quantity of cream to a desired temperature 56° F. Fahrenheit scale. Temperature of skim milk, 150° F.

AMT. CREAM	35°	36°	37°	38°	39°	40°	41°	42°	43°	44°	45°	46°	47°	48°
Lb.														
25	5.06	4.82	4.58	4.34	4.10	3.85	3.61	3.37	3.13	2.89	2.65	2.41	2.17	1.93
50	10.13	9.64	9.16	8.68	8.20	7.72	7.23	6.75	6.27	5.79	5.30	4.82	4.34	3.86
75	15.19	14.47	13.75	13.02	12.30	11.58	10.85	10.13	9.41	8.68	7.96	7.24	6.51	5.78
100	20.26	19.29	18.33	17.36	16.40	15.43	14.47	13.50	12.54	11.57	10.61	9.64	8.68	7.71
125	25.32	24.12	22.91	21.71	20.50	19.29	18.09	16,88	15.68	14.47	13.26	12.06	10.85	9.64
150	30.39	28.94	27.49	26.05	24.60	23.15	21.70	20.26	18.81	17.36	15.92	14.47	13.02	11.57
175	35.47	33.77	32.08	30.39	28.70	27.01	25.32	23.63	21.95	20.26	18.57	16.88	15.19	13.50
200	40.52	38.59	36.66	34.73	32.80	30.87	28.94	27.01	25.08	23.15	21.22	19.29	17.36	15.43
250	50.39	47.99	45.59	43.19	40.79	38.39	35.99	33.59	31.19	28.79	26.39	23.99	21.59	19.19
300	60.78	57.89	55.00	52.10	49.20	46.31	43.41	40.52	37.63	34.73	31.84	28.94	26.05	23.15
350	70.91	67.54	64.16	60.78	57.40	54.03	50.65	47.27	43.90	40.52	37.14	33.77	30.39	27.01
400	81.04	77.18	73.33	69.47	65.61	61.75	57.89	54.03	50.17	46.31	42.45	38.59	34.73	30.87
500	101.31	96.48	91.66	86.83	82.01	77.18	72.36	67.54	62.71	57.89	53.06	48.24	43.42	38.59

the space permitted or the work in butter making required thousandth parts of a pound of skim milk the tables could be made to reach a definite rate of decrease in numbers from left to right on every horizontal line.

The per cent of water content of the butter was influenced in every instance by the temperatures employed, the per cent of fat being almost constant (30 per cent) in the cream used. Where the temperature of the wash water was higher than that of the butter a higher per cent of moisture was obtained.

Where cream was held at a comparatively high temperature, 55° F. to 60° F., it churned very rapidly. Butter churned in this manner has irregular shaped granules which contain more moisture than the small round granules of butter churned at low temperatures.

The cream churned below 48° F. for an hour and warm milk added produced a combination of the two which gave the proper moisture content, from 12 per cent to 15.8 per cent.

When the temperatures were equal the moisture content of the butter from unpasteurized cream was slightly higher than that of pasteurized cream. No difference in moisture content was noticed between butter made from cream containing skim milk, whole milk, or cream starters.

Where starter was added to the cream two hours before churning the moisture of the resulting butter averaged 12 per cent. That of the butter where lactic acid was added and worked in after washing, 13.5 per cent; where no starter was used, 11 per cent; when the cream was ripened normally, 13 per cent; when it was ripened with starter, 14.5 per cent.

CONCLUSIONS

1. Normal sweet cream may be successfully churned at temperatures below 52° F. when from 20 to 30 per cent of good starter has been added. When churned at higher temperatures or without starter the loss of fat was too great to warrant the adoption of this method.

2. There was slightly less loss of fat in the buttermilk from cream ripened with good starter than from cream to which starter had been added only two hours previous to churning, but the score of the latter was enough higher to more than counterbalance this difference.

3. Natural starters proved less effective than starters made from commercial cultures.

There was practically no difference in the flavors produced in butter by the use of skim milk, whole milk, or cream starters. The cream starters are better adapted for use in thin cream, and skim and whole milk starters are better for use in thick cream.

4. Better results were obtained from pasteurized than from unpasteurized cream of low grade, less difference being noted in high grades of cream.

Immediate and efficient cooling after heating proved to be an essential part of pasteurization, in destroying the bacteria present, and for maintaining the texture of the butter made from pasteurized cream.

5. The use of commercial lactic acid as a substitute for starter proved advantageous only when used in very rancid cream or on butter from such cream after washing the butter thoroughly.

6. A greater loss of fat in the buttermilk resulted from the use of low grades of cream than from high grades of cream by every process of ripening and manufacture employed.

7. The addition of warm skim milk to cream which had been churned at temperatures below 48° F. proved very effective in causing the butter to gather quickly and in securing exhaustive churnings.

Plate No. I, showing colonies of bacteria developed from $\frac{1}{10}$ cc. of normal unpasteurized cream.

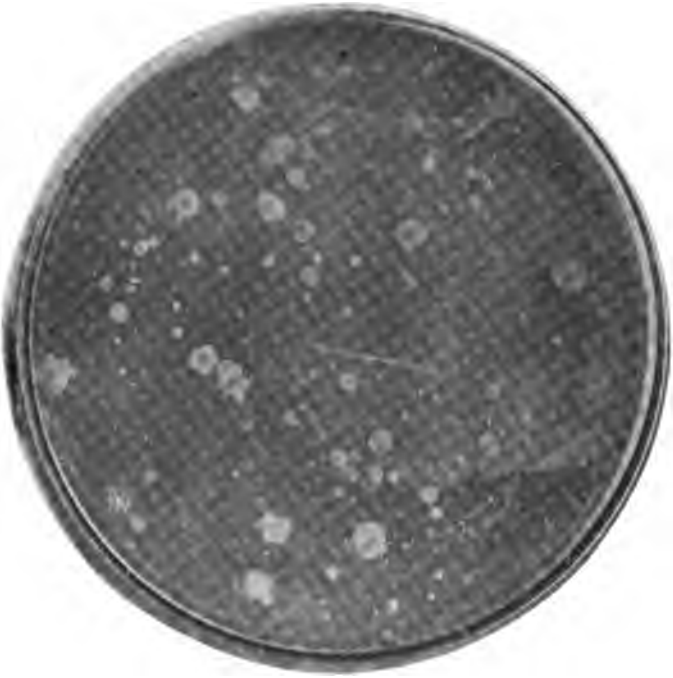


Plate No. II, showing the relatively small number of colonies developed from $\frac{1}{10}$ cc. of cream which had been pasteurized at 155° F., without subsequent cooling.

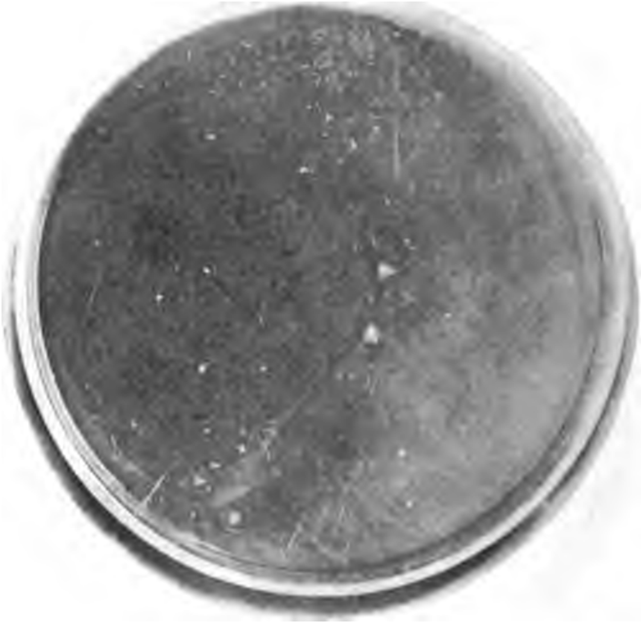


Plate No. III, showing the insignificant number of colonies developed from $\frac{1}{10}$ cc. of cream which had been pasteurized at 155° F. and cooled immediately to 50° F.

Plates Nos. II and III were allowed to develop twelve hours longer than No. I, and the colonies are therefore larger. Plate No. I would not admit of further development without forming a continuous growth over the entire plate.

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WHIPPED CREAM

BY C. W. MELICK

Whipped cream is a term applied to cream which has been whipped or beaten into a foam by rapid agitation, the principle being similar to that employed in beating eggs; namely, the incorporation of a considerable volume of air.

A good quality of whipped cream consists of a dense foam of cream which has sufficient body or firmness to enable it to stand up well.

Although large quantities of whipped cream are used for confectionary purposes there is no available data published on investigations along this line.

Baltimore, Washington and many other large cities use a considerable quantity of cream for such purposes and their confectioners frequently experience difficulty in effecting proper whipping.

The following replies to inquiries sent to city confectioners regarding the whipping of cream are of interest in this connection.

1. "We use only separator cream, double cream. You cannot obtain heavy enough gravity cream to whip properly. Pasteurization spoils cream for whipping."

2. "We use gravity cream for whipping. Pasteurized cream will not whip."

3. "We use either separated or gravity cream just so it is thick enough to whip. Pasteurized cream will not whip unless it has been thoroughly chilled."

4. "We don't know whether our cream is separator or gravity. It is double cream. We never tried pasteurized cream for whipping."

The views of each were substantiated by various other confectioners who either concealed their trade secrets or differed in their opinion on this question.

Upon personal inquiry many of them had used separator and pasteurized cream before permitting it to remain long enough at low temperatures. Having been unsuccessful in their attempts to whip such cream they were prejudiced against it.

With a view of ascertaining the causes of difficulties thus encountered, to effect if possible the remedies, and the kind of cream best suited for whipping purposes, the following investigations were conducted to determine:

1. Effect of butter fat content on the whipping quality of cream.
2. Effect of lactic acid on the whipping quality of cream.
3. Effect of pasteurization on the whipping quality of cream.
4. Effect of temperature on the whipping quality of cream.
5. Effect of centrifugal separation on the whipping quality of cream.
6. Effect of sugar on the whipping quality of cream.
7. Effect of salt on the whipping quality of cream.
8. Effect of dried milk powder on the whipping quality of cream.
9. Effect of viscogen on the whipping quality of cream.
10. Effect of gelatine on the whipping quality of cream.
11. Effect of junket on the whipping quality of cream.
12. Effect of cornstarch on the whipping quality of cream.
13. Effect of vanilla on the whipping quality of cream.
14. Effect of caramel on the whipping quality of cream.
15. Effect of egg albumen on the whipping quality of cream.
16. Effect of lactation period on the whipping quality of cream.

The cream used in every experiment was whippd in 50 cc. sample lots in a 400 cc. porcelain mortar, with a Dover egg beater so as to subject each sample to similar conditions.

Normal sweet gravity cream was taken as a standard and whipped in comparison with separator and pasteurized cream, and with cream to which each of the above ingredients had been added.

EFFECT OF BUTTER FAT CONTENT ON THE WHIPPING QUALITY OF CREAM

Samples of fresh, normal cream right from the separator, containing from 15 to 50 per cent butter fat would not whip immediately after cooling to 40° F. Cream from one to forty-eight hours old containing less than 20 per cent fat and less than 0.25 per cent acid would not whip at temperatures above 40° F. Cream containing 20 per cent or more of butter fat and having been held at 40° F. or below for at least one hour whipped without difficulty.

In the following table each sample of cream contained 0.15 per cent acid and had remained at 45° F. for two hours,

Per cent fat in cream	20	25	30	35	40
Average time required to whip	1m. 40s.	1m.	50s.	35s.	25s.

Other conditions being equal there was an almost definite ratio between the fat content and time required to whip.

THE EFFECT OF LACTIC ACID ON THE WHIPPING QUALITY

The older the cream up to the point of separation of whey from clabber the better it whipped. For this reason gravity cream of the same fat content whipped better than fresh separator cream, twelve hours usually being required to raise. This was accompanied by a development of 0.2 to 0.3 per cent of lactic acid. Samples of cream were also whipped with and without commercial lactic acid so as to overcome any changes which would occur were the cream allowed to remain at various temperatures while lactic acid increased naturally. In every instance the cream to which commercial lactic acid had been added whipped in less time and produced a denser foam than did that to which no acid had been added.

Five-tenths per cent of commercial lactic acid, or cream testing three-tenths per cent normal acid, was the maximum quantity necessary to produce best results. This is approximately one teaspoonful of acid to two teacupfuls of cream. Cream containing this amount of acid and only 10 per cent of fat whipped at temperatures below 45° F. after having been held at such temperatures for two hours or more.

Lactic acid either natural or commercial at low temperatures effected a gelatinous consistency of the casein and albumin of the cream, which rendered it capable of holding a considerable quantity of air, thus facilitating whipping.

In the table on the following page each sample of cream had been held at 45° F. for two hours.

Here the effect of lactic acid proved to be of greater importance than that of the fat content. The fat content proved the more important factor until cream reached 20 per cent. Above this point the acid content was the more important. Three-tenths of a per cent of acidity is the maximum which cream may contain without acquiring a sour taste.

Time Required to Whip Cream of Varying Acidity

Per cent acid in cream..	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Per cent Fat										
15..............							1m. 30s.	1m. 20s.	1m.	50s.
20..............	1m. 50s.	1m. 30s.	1m. 20s.	1m. 10s.	1m.	50s.	42s.	34s.	30s.	30s.
25..............	1m. 10s.	55s.	50s.	41s.	37s.	32s.	28s.	25s.	23s.	23s.
30..............	55s.	45s.	40s.	37.s	34s.	30s.	26s.	23s.	22s.	22s.

The addition of commercial lactic acid in small quantities had no effect on the natural development of acid.

EFFECT OF PASTEURIZATION AND TEMPERATURE ON THE WHIPPING QUALITIES OF CREAM

Samples of cream were pasteurized at temperatures varying from 140° F. to 185° F. and cooled to 50° F., 45° F., and 40° F. Although these samples contained from 20 per cent to 50 per cent butter fat none of them would whip immediately after pasteurizing. After remaining at a low temperature until the milk solids congealed, pasteurized cream whipped as readily as did unpasteurized cream. This congealing in case of the fat globules required an average of 35 minutes at 40° F., an hour at 45° F., and two hours at 50° F., when placed in water at these temperatures in pint milk jars. The other solids congealed much more rapidly. The time was taken as soon as the samples had actually reached the above temperatures, which required only a few minutes. When allowed to cool in the air as a medium the process was slow. In such instances the fat globules congealed while the other solids were cooling, and the cream was ready to whip as soon as cooled.

The smaller the quantity in proportion to exposed surface the less time required to cool in a cold medium. Pasteurization therefore has no permanent detrimental effect upon the whipping qualities of cream.

Samples of cream were also heated to 80° F. and placed in 250 cc. (1 teacupful) lots, in flat pans ten inches in diameter, and in beakers two and five-eighths inches in diameter and three and one-half inches deep. They were allowed to remain in rooms of various temperatures until whipping could be effected. An average of the results thus obtained are summarized in the following table.

The table illustrates the difference in the time required to cool cream of different percents of fat, and varying in exposed surface. The samples contained 250 cc. each and were brought to a temperature of 80° F. at the time they were put into the various vessels. The shallow pans were ten inches in diameter, and the cream when poured into them was one-fourth inch deep. The beakers as above described contained the same quantity of milk as the shallow pans, but the volume was two and five-eighths inches in diameter and three and one-half inches deep.

From these results it will be readily seen that the richer the cream the more time required to cool, and that an almost constant ratio exists between the density of the cream and the rate of cooling. This proved

		TEMPERATURE OF ROOM											
		40° F.				45° F.				50° F.			
Per cent fat in cream		20	23	26	30	20	23	26	30	20	23	26	30
Time required to cool to room temperature in	shallow pans	1h. 30m.	2h.	2h. 25m.	2h. 50m.	2h.	2h. 20m.	2h. 40m.	3h. 10m.	2h. 40m.	3h.	3h. 24m.	3h. 50m.
	beakers	4h.	4h. 30m.	5h.	5h. 30m.	4h. 30m.	5h.	5h. 30m.	6h. 55m.	4h.	5h. 20m.	5h. 50m.	6h. 30m.
Time required for fat globules to congeal sufficiently to whip normally in	shallow pans	1h. 45m.	1h. 55m.	2h. 8m.	2h. 25m.	1h. 50m.	2h. 10m.	2h. 30m.	2h. 40m.	2h.	2h. 20m.	2h. 50m.	3h.
	beakers	4h.	4h. 30m.	5h.	5h. 30m.	4h. 30m.	5h.	5h. 30m.	6h.	4h. 55m.	5h. 20m.	5h. 50m.	6h. 30m.

true only where the atmosphere of the room remained constant. When the room temperature was lowered, where the air was stirring, or a draught was present, the cream cooled much more rapidly than in the cases cited in the above table.

When whipped, after remaining at these temperatures less time than this, the pasteurized cream and separated cream which had been heated required more time for whipping than did the unpasteurized or unheated gravity cream.

The difference in the whipping quality of warm and cooled cream proved to be due to the more viscous condition of the cold cream caused by the congealing of the casein and albumin, in which condition more air is incorporated in whipping.

The temperature of the room in which cream was whipped had a marked influence upon its whipping quality. When whipped in a room with a temperature of 70° F. cream at 50° raised to 68° F. by the time whipping was effected. When cream of a low fat content or otherwise difficult to whip was vigorously beaten in a room of 65 to 70° F. it invariably failed to whip.

EFFECT OF CENTRIFUGAL SEPARATION ON WHIPPING QUALITY OF CREAM

Centrifugal and gravity cream of identical composition were whipped at various temperatures immediately after separating, and after having been allowed to remain at low temperatures from ten minutes to three hours.

No difference could be noted in their whipping qualities after the milk solids were allowed to congeal. Milk is usually separated at from 60° to 100° F. and the cream coming from the separator at such temperatures would not whip. Neither would gravity cream whip at those temperatures. Gravity cream skimmed in the normal way without heating naturally required less cooling. Centrifugal force had no detrimental effect upon the whipping quality of cream and the heating which it necessitated had no permanent detrimental effect on it.

To further substantiate the uniformity of results obtained by the use of separator and gravity cream when properly cooled and the results obtained by the use of commercial lactic acid, samples of normal gravity cream numbered 1, gravity cream containing 1 per cent acid numbered 2, normal separator cream numbered 3, and separator cream containing one per cent of acid numbered 4, all of the same fat content, were sent to several confectioners for their opinion of the comparative whipping qualities.

The following is a summary of the five replies received:

Numbers 2 and 4 whipped in less time and had a stiffer foam in every instance with but one exception, in which number 3 was reported to have been whipped in the same length of time as numbers 2 and 4.

The time required to whip numbers 1 and 3 from all replies averaged exactly the same. The average time required to whip numbers 2 and 4 showed only 6 seconds difference. The average difference between the time required to whip numbers 2 and 4 and 1 and 3 was 1 minute and 14 seconds, various amounts and temperatures being used by different confectioners.

EFFECT OF SUGAR, SALT AND DRIED MILK POWDER ON THE WHIPPING QUALITY OF CREAM

Each of the powdered substances used facilitated whipping by reducing the per cent of water content, and when cooled by rendering the cream more viscous. The sugar, casein and albumin of the milk powder, and the action of the salt on the casein increased the viscosity of the cream to which they were added.

The more viscous the cream the more readily it incorporated air at low temperatures.

Each powdered substance aided slightly in lessening the time of whipping, and in some instances caused cream to whip which otherwise would not.

No difference could be noted in the whipping qualities of cream to which milk sugar, powdered cane sugar, or dried milk powder had been added, and since powdered sugar is cheaper than either of the other products only the detailed results of its use is reported in the tables.

EFFECT OF VISCOGEN ON THE WHIPPING QUALITY OF CREAM

Viscogen or sucrose of lime, is made by adding two and one-half parts of sugar, or all that will dissolve, to five parts of water and three-tenths part milk of lime. Mix thoroughly and allow to stand 24 hours before using.

It is called viscogen because of its tendency to restore the viscosity in pasteurized cream immediately after pasteurizing. Pasteurization at 150° F. or above reduces the viscosity of cream temporarily either by loosening the galactase which holds the fat globules in groups or by causing a disarrangement of the calcium salts of milk or both. This disarrangement is gradually restored to a normal state by allowing such cream to remain for several hours at low temperatures. It is rapidly restored, however, by the addition of lime-water of viscogen. The sugar of the viscogen furnishes food for the lactic acid producing bacteria and by their growth the lactic acid is increased.

Pasteurized cream, as was repeatedly demonstrated, should therefore be allowed to cool for several hours before whipping. For best results if it contains less than 0.2 per cent of acid, it should be inoculated with a small amount of lactic acid starter or have 0.5 per cent to 1.0 per cent of commercial lactic acid added.

Viscogen is an alkali and neutralizes the acidity of cream to which it is added and thus delays souring. When made of commercial lime not over two ounces could be used in five gallons of cream without causing an undesirable odor and bitter taste. Two ounces of viscogen combined with a low temperature proved sufficient to restore the viscosity in five gallons of sweet cream.

The viscosity of pasteurized cream was restored equally as well in these investigations by holding it at low temperatures for several hours longer without the use of viscogen as when the latter was used.

The viscogen used in these experiments was made of chemically pure lime-water. Viscogen thus made may be used in larger quantities than that made from ordinary commercial lime, without injuring the flavor of the cream to which it is added. It was found necessary to use 1 per cent of viscogen in cream which was to be whipped immediately after adding.

EFFECT OF CARBON DIOXIDE ON THE WHIPPING QUALITIES OF CREAM

Carbon dioxide (CO_2) is the gas which is given off from baking soda. It is the gas which is used in soda-water to produce the sparkle and foam. In obtaining it for this work baking soda was treated with sulphuric acid and the CO_2 which was liberated was conducted into the cream. In these tests gravity, separator and pasteurized cream was used.

There was no apparent difference in the whipping quality of cream saturated with CO_2 and untreated cream. Cream saturated at low temperatures, however, produced a foam which remained sweet longer than did that of untreated cream.

The addition of this gas at 60° F. merely lessened the keeping quality of the cream. At that temperature only a small amount of the gas seemed to be retained, and holding cream at such a high temperature long enough to saturate it proved detrimental to its keeping qualities. The lower the temperature the more CO_2 was incorporated and the better was its keeping quality.

The amount of CO_2 that was incorporated into cream even at low temperatures, however, without pressure aided its keeping quality only slightly.

Van Slyke and Bosworth of the Geneva Experiment Station subjected milk to carbon dioxide gas under pressure of 70, 150 and 175 pounds per square inch, with the following results: Application of CO_2 at 70 pounds pressure delayed the souring of milk beyond the eighth day, and at 150 pounds pressure it made no increase in acidity in nine months.

Mowry and Michel[1] state as a result of some of their work that milk saturated with carbon dioxide would keep at a low temperature for eight days. They also state that the effect of carbon dioxide is merely to check the growth of the bacteria. The bacteria are not killed.

Foa[2] investigated the action of carbon dioxide gas under pressure of thirty to seventy-five pounds upon various organisms and found that it had a checking influence upon the development of organisms but does not act on enzymes or toxins. Under sixty pounds pressure it checked alcoholic fermentation.

Hoffman[3] treated fresh milk with carbon dioxide under pressure of 750 pounds for several hours. Bacteria present in the milk were capable of growth after the milk was relieved from pressure.

Van Slyke and Bosworth also found "that the addition of sucrose alone did not delay the souring of milk, that the addition of yeast alone apparrently delayed the fermentation of acid slightly, that the addition of yeast and five grams of sucrose did not reduce the acidity much below that of milk to which yeast alone was added, that the addition of larger amounts of sugar along with yeast delayed the souring of milk to such extent that coagulation did not occur for five or six days or longer."

From this the advantage of carbon dioxide in whipped cream is obvious. It will not aid in whipping, but if introduced under pressure, and held under pressure after whipping, the cream may be retained sweet for a considerable length of time.

EFFECT OF GELATINE, JUNKET AND CORNSTARCH ON THE WHIPPING QUALITY OF CREAM

The use of gelatine, junket and cornstarch facilitated whipping of cream at from 45° to 60° F., and gelatine and cornstarch caused it to stand up better in the temperature of the average room, which is 70° F.

[1] Compt. Rend., 115, 959-960, 1892.

[2] Chem. Centbl. 77, 11: 695. 1906.

[3] Arch. Hyg. 57: 379. 1906.

Temperatures below 45° F. were as effectual as the addition of any of these ingredients; at temperatures above 60° F. cream failed to whip even with the addition of one or more of the ingredients. These ingredients were added to the cream in a liquid state and allowed to thicken, forming the cream into a jelly-like mass. 10 per cent of gelatine, 20 per cent of cornstarch and one junket tablet per quart of cream were the maximum amounts required to produce the best results.

A comparison of their effect on the whipping quality is given in the general summary.

EFFECT OF CARAMEL ON THE WHIPPING QUALITY OF CREAM

The caramel used in these experiments was made by heating granulated sugar while stirring until it melted and turned dark brown. At this point an equal quantity of boiling water was added and the whole allowed to boil into a syrup. When cooled it could be poured with difficulty. In this condition air was readily incorporated into it by whipping. The addition of 10 per cent of caramel imparts a very pleasing flavor, and facilitates whipping between 45 and 60° F.

For comparison of effect of caramel with other ingredients see summary.

EFFECT OF EGG ALBUMEN (WHITE OF EGG) ON THE WHIPPING QUALITY OF CREAM

The addition of egg albumen at 40° F. or above, unless whipped before adding, retarded the whipping of cream to which it had been added. At temperatures below 40° F. when added with a few drops of lactic acid it did not retard the whipping, but tended to produce a lighter foam.

The effect of lactic acid on albumen, although slight in comparison to its effect on casein, produced a somewhat gelatinous consistency which aided the incorporation of air in whippng.

EFFECT OF VANILLA EXTRACT ON THE WHIPPING QUALITY OF CREAM.

In view of the fact that vanilla flavoring is used extensively in confectionary products its effect on the whipping quality of cream was determined.

The vanilla extract used in these investigations contained 8.4 per cent dilute alcohol. Alcohol has a great affinity for water and naturally absorbs small quantities of it from most substances to which it is added.

Five drops of the extract were used in 50 cc. of cream. In such small quantities it had practically no effect on the whipping quality of cream.

THE QUANTITY OF THE VARIOUS INGREDIENTS WHICH MAY BE ADDED TO CREAM

The per cent of ingredients used in the experiments from which the following table was compiled represents the amount of each that was used without injury to the taste or flavor of the whipped cream for any or all purposes.

The percentages used were as follows: 1 per cent of powdered sugar, 0.5 per cent of salt, 0.5 per cent of lactic acid, 1 per cent of viscogen, 10 per cent of caramel, 10 per cent of gelatine, 20 per cent of cornstarch, one junket tablet per quart of cream, five drops of vanilla extract per 50 cc. of cream, and where carbon dioxide was used the samples of cream were saturated at a temperature of 45° F.

For the convenience of those who have no facilities for measuring and have no time to figure percentages, the following may be helpful.

½ per cent = 1 teaspoonful to 4 teacupfuls, approximately.
1 per cent = 1 teaspoonful to 2 teacupfuls, approximately.
2 per cent = 1 teaspoonful to 1 teacupful, approximately.
10 per cent = 1½ tablespoonfuls to 1 teacupful, approximately.
20 per cent = ⅕ teacupful to 1 teacupful, approximately.

The average acidity of the cream used in the following table was 0.2 per cent with an average fat content of 30 per cent. The average temperature was 50° F. The samples were all held at this temperature for three hours. The average temperature of the room in which the cream was whipped was 55° F.

It will be noticed in the preceding table that the samples of unwhipped cream remained sweet longer than did the samples of whipped cream.

The excessive amount of air incorporated in the whipped cream increases its bulk and reduces its density, thereby producing a more favorable condition for bacterial growth.

There was no apparent difference in the acid development of whipped and unwhipped cream until after 12 hours. The whipped cream then began to show an increased per cent of acid.

None of these ingredients except lactic acid facilitated the whipping of cream which had been held at 40° F. or below. This temperature together with the results obtained from it, was in itself sufficient.

Cooling, therefore, proved to be of far more importance than the addition of any ingredient except lactic acid.

Table Showing the Effects of the Addition of Various Ingredients on the Whipping Quality of Separator and Gravity Cream

	PLAIN CREAM.	POWDERED SUGAR.	SALT.	LACTIC ACID.	VISCOGEN.	CARBON DIOXIDE.	GELATINE.	JUNKET.	CORNSTARCH.	VANILLA.	CARAMEL.
Time required to Whip in seconds.											
Separator Cream	50	41	42	25	30	50	40	40	45	49	45
Separator cream, pasteurized	50	40	40	25	30	50	41	40	44	50	44
Gravity cream	50	40	42	25	30	50	40	40	45	50	45
Gravity cream, pasteurized	51	40	41	26	30	50	40	40	45	49	45
Acidity of whipped cream at end of 24 hours at 55° F.											
Separator cream	0.26	0.26	0.26	0.25	0.22	0.24	0.3	0.27	0.28	0.23	0.28
Separator cream, pasteurized	0.25	0.24	0.25	0.25	0.21	0.23	0.3	0.28	0.28	0.23	0.28
Gravity cream	0.26	0.25	0.26	0.26	0.22	0.24	0.3	0.28	0.28	0.23	0.28
Gravity cream, pasteurized	0.24	0.23	0.24	0.24	0.21	0.23	0.3	0.28	0.28	0.23	0.28
Acidity of whipped cream at end of 48 hours at 55° F.											
Separator cream	0.33	0.33	0.33	0.31	0.25	0.3	0.36	0.32	0.33	0.26	0.34
Separator cream, pasteurized	0.3	0.31	0.31	0.3	0.24	0.28	0.36	0.32	0.33	0.26	0.34
Gravity cream	0.32	0.32	0.33	0.31	0.25	0.29	0.36	0.32	0.33	0.26	0.34
Gravity cream, pasteurized	0.29	0.3	0.31	0.29	0.24	0.27	0.36	0.32	0.33	0.26	0.33
Acidity of unwhipped cream at end of 48 hours at 55° F.											
Separator cream	0.31	0.31	0.30	0.29	0.22	0.28	0.33	0.3	0.3	0.24	0.31
Separator cream, pasteurized	0.27	0.28	0.28	0.28	0.22	0.26	0.32	0.3	0.3	0.24	0.31
Gravity cream	0.30	0.30	0.30	0.29	0.22	0.27	0.33	0.3	0.3	0.24	0.31
Gravity cream, pasteurized	0.26	0.28	0.29	0.27	0.22	0.26	0.32	0.3	0.29	0.24	0.3

The amount of powdered sugar, salt, viscogen, or lactic acid that may be used in cream for confectionary purposes depends entirely upon the amount of flavoring and sweetening that is desired. In fruit puddings, for instance, where sugar and spices are used with fruit, larger quantities of the above ingredients may be used in the whipped cream coating without affecting the taste of the product.

The heaviest cream generally produced the heaviest foam when whipped.

It is difficult to obtain gravity cream that will test 30 per cent fat or above. Cream testing less than this contains such a large per cent of water which has to be overcome in whipping that it cannot be done satisfactorily unless it has been held at a very low temperature for several hours.

While there is practically no difference in the keeping quality of the untreated cream and that treated with salt, milk sugar, or lactic acid, in the quantities here used, the cream treated with viscogen and carbon dioxide remained sweet from twelve to twenty-four hours longer.

From these observations it is evident that the success of whipping cream depends upon the congealing of the solids contained therein, and the development of a small amount of lactic acid.

EFFECT OF LACTATION PERIOD ON THE WHIPPING QUALITY OF CREAM.

Cream from cows nearing the end of their lactation period whipped with much more difficulty than did cream from cows near the beginning of their lactation period. This is probably due to the physical condition of the milk solids, especially the fat globules which at this period are smaller and harder than in the earlier part of the lactation period.

Sixteen cows from the Station herd were used in this experiment, including Holsteins, Jerseys, and grades. Eight of these were almost dry, giving from one quart to one gallon of milk a day per head. The other eight cows were practically fresh, having calved from two months to a week before the experiment began. The same number of each breed was used in each group to eliminate any possibility of breed variations.

The following table illustrates the average differences found in whipping quality of cream, due to differences in lactation period.

The temperature, per cent of fat, and acid were the same in both groups in each experiment.

Time Required to Whip

PER CENT FAT.	CREAM FROM COWS AT THE BEGINNING OF LACTATION PERIOD.	CREAM FROM COWS NEAR THE END OF LACTATION PERIOD.
25	1m.	1m.25s.
30	50s.	1m.10s.
33	40s.	55s.
37	30s.	50s.

The cream used in the above tests was obtained both by gravity and by centrifugal separation, no difference being noted in their whipping qualities when properly cooled, and of the same acid content.

Summary.

These investigations indicate that the whipping of cream depends upon a number of points and that some of the additions which are made to cream which is used for whipping are beneficial while others contribute little to its value for this purpose.

The principal points brought out by the investigation may be classified as follows:

1. There was no difference in the whipping qualities of gravity and separator cream. When any difference is experienced it is due to other factors and not to the method of getting the cream from milk.
2. Cream for whipping purposes should contain at least 20 per cent butter fat. The best results were obtained with cream containing from 25 per cent to 40 per cent butter fat.
3. For best results cream should be held at as low a temperature as possible (35° to 45° F.) for at least two hours before whipping, and should be whipped in a cool room.
4. For good results cream should be from 12 to 24 hours old. This gives an opportunity for the development of a small amount of acid in the cream. The acid effected a gelatinous consistency in the casein and albumin and thus facilitated the incorporation of air in whipping. When it is desired to whip fresh cream 3/10 per cent commercial lactic acid may be added to take the place of the acid which would develop by setting the cream from 12 to 24 hours.
5. Pasteurized cream may be whipped as easily as unpasteurized cream if it is thoroughly cooled and held at 35° to 45° F. for at least two hours before whipping.

6. For good results cream should whip in from 30 to 60 seconds. When a longer time is required there is danger of some of the butter fat separating or churning.

7. The addition of one-tenth to three-tenths per cent of commercial lactic acid to cream facilitated its whipping and made it possible to whip cream which was fresher, which contained less butter fat and which was warmer than is advisable for the best results.

8. The use of viscogen facilitated the whipping of cream to a greater extent than any other ingredient with the exception of lactic acid. It proved less effective than the latter and also less effective than a low temperature. The addition of viscogen caused cream to remain sweet from 12 to 24 hours longer than it otherwise would.

9. The use of powdered sugar, powdered milk, salt, caramel, gelatine, junket, and cornstarch, each facilitated the whipping of cream to a small degree, and each to practically the same extent. None of them proved as effective as a low temperature and the development or addition of lactic acid. The addition of an excess of gelatine above 10 per cent or of cornstarch above 20 per cent caused a lumpy cream when whipped.

10. The use of egg albumen with cream when whipped separately and mixed, produced a lighter foam, but had no effect upon the time required to whip. When mixed before the egg albumen was whipped, at temperatures above 40° F., the whipping was retarded.

11. The use of vanilla extract used in ordinary quantities had no effect upon the whipping qualities of cream.

12. The charging of cream with carbonic acid gas without pressure had no effect on its whipping qualities but caused it to remain sweet from 12 to 24 hours longer.

13. The use of cream from cows near the end of their lactation period whipped with slightly more difficulty than did cream from fresh cows.

14. Whipped cream will not keep sweet as long as unwhipped cream.

15. When any additions are made to cream to facilitate whipping it should be so labeled as to not deceive the purchaser.

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OF THE DIRECTOR

OF THE

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